THE

GEOLOGICAL MAGAZINE

VOLUME LXIII.

No. XII.—DECEMBER, 1926.

ORIGINAL ARTICLES.

Lepidesthes howsei sp. nov., a Carboniferous Echinoid from Northumberland.

By Robert Tracy Jackson.

(PLATE XXX.)

ECHINI from the Palaeozoic formations are rare, and rarer still is it to find a new form of one of the more specialized genera in good condition of preservation. It was a keen pleasure to me, therefore, when my friend Dr. F. A. Bather, of the British Museum, recently gave me the privilege of studying and reporting on the specimen here described. It proves to be a species of the highly specialized genus *Lepidesthes* from the Lower Carboniferous, and was sent to Dr. Bather for study by the authorities of the Hancock Museum, Newcastle-on-Tyne.

The genus *Lepidesthes* was previously known from ten species, seven from the Lower Carboniferous of America, two from Great Britain, and one from the Carboniferous of Russia. It is one of the most specialized genera of Palaeozoic Echini on account of the strong imbrication of the coronal plates and also on account of the large number of columns of plates in the ambulacra. The structurally simplest of known species of the genus, *Lepidesthes wortheni* Jackson, has eight columns of plates in each ambulacral area, with only three columns in each interambulacral area. The most specialized species, *L. colletti* White, has sixteen columns of plates in each ambulacrum and either four or five columns in each interambulacrum. These are all considered in my monograph on Palaeozoic Echini.[1]

Lepidesthes howsei sp. nov.

Diagnosis.—Test circular in horizontal plane, flattened in the specimen, but in life probably rather low dome-shaped. The surface of the test presents an even, continuous outline, not elevated into melon-like ribs as in some species of the genus; plates thin, scale-like, very small, crowded. Ambulacral plates imbricating strongly adorally, interambulacral imbricating strongly adapically and from the centre outward and over the adjacent ambulacrals on each side.

---

[1] Jackson, 1912, " Phylogeny of the Echini " : *Mem. Boston Soc. Nat. Hist.*, vol. vii.

Ambulacra nearly twice as wide as interambulacra. Twelve columns of plates in each ambulacrum. Ambulacral plates very small; near the periphery the plates as seen from within about 1·5 mm. wide, and lower than wide. Further dorsally, they are smaller, crowded and rhombic in shape. Tubercles small secondaries, spines not preserved.

Interambulacra with seven columns of small rounded scale-like plates in each area; tubercles and spines not preserved, probably small secondaries. Five genitals, each with several pores. Indications of the lantern.

Measurements of Holotype.—As measured through an interambulacrum and opposite ambulacrum, in the planes *A–F*, *E–J*, and *G–B* the specimen is 66 mm. in diameter; through the plane *C–H* it measures 62 mm., and through *I*, *D*, 60 mm. Ambulacra at the periphery, measured in a straight line, about 22 mm. wide; interambulacra at the periphery about 12 mm. wide.

Locality and Horizon.—The holotype and only known specimen of *Lepidesthes howsei* is from the Lower Carboniferous Ironstone Shale of Redesdale, Northumberland. It was collected by the late Mr. Richard Howse, who was the Curator of the Hancock Museum, and in whose honour it is named. It is the property of the Hancock Museum, Newcastle-on-Tyne, and was sent to Dr. Bather, 8th August, 1922, for study.

Comparison.—There are only two other recorded British species of the genus and both are only partially known: namely, *Lepidesthes devonicans* Whidborne, of the Polton Beds, North Devon, with holotype in the Museum of Practical Geology, Jermyn Street, Nos. 7160 and 7161 (counterparts); and *L. caledonica* Jackson, from Roscobie, Fife, with holotype and paratypes in the British Museum, E 10,699–E 10,723, and additional paratypes in the Jermyn Street Museum, Nos. 16,308–9. *Lepidesthes howsei* sp. nov. differs from *L. devonicans* in having smaller, thinner, less angular plates, and in having twelve instead of only eight (apparently) columns of plates in the ambulacral areas. *L. howsei* differs from *L. caledonica* (which is only fragmentarily known), in having much smaller, less robust plates. In the character of the plates, *L. extremis* Jackson, from the Lower Carboniferous of Ohio, U.S.A., is the one among known species of the genus which perhaps most closely resembles *L. howsei*. *L. extremis* also has thin, scale-like plates, but differs in having sixteen columns in each ambulacrum and only four columns in the interambulacra.

Detailed Description and Discussion.—This remarkable specimen of a most extreme and interesting genus is exceptionally perfect in its preservation. It is on a flat slab of black, very carbonaceous, shaly limestone, which, besides the echinoid, has numerous more or less complete fragments of crinoids, brachiopods, and corals. The slab is rather weak and has been backed up to strengthen it.

The echinoid specimen, seen in the dorsal view, is flattened out on the slab, but the periphery is perfectly entire without fracture or dislocation, and, although parts of the dorsal portion of the test are gone, there is no indication of torsion or disruption of the test. The area of the apical disc is practically in the centre of the specimen and all the indications are that after death the dorsal portion quietly settled down on to the ventral until it was in a measure stopped by coming in contact with the relatively rigid lantern. At six points the thin test is pushed up, and in part abraded, by what are evidently the dorsal tips of six of the ten half-pyramids of the lantern. These were pushed into the flexible test much as a misplaced tent pole might press into the stretched canvas of a tent. The settling down process of the test to its present thinness was doubtless rendered possible largely by the extreme flexibility due to a strongly imbricate thin-plated test. It however indicates markedly that the test in life was probably only moderately high instead of being spheroidal, or even vertically elongate as in other species of the genus in which the form of the test is fairly well known. In *Lepidesthes formosa* Miller, *L. spectabilis* Worthen & Miller, *L. coreyi* Meek & Worthen, and *L. carinata* Jackson the test is nearly or quite spheroidal; on the other hand, in *Lepidesthes wortheni* Jackson and in *L. colletti* White[1] (all from the Lower Carboniferous of America) the height by a considerable amount exceeds the horizontal diameter of the test, which is a very unusual character in fossil or recent Echini. Apparently therefore, *Lepidesthes howsei* was much lower in its vertical height than other known species of this genus, and in fact probably lower than in most species of Palaeozoic Echini, for the majority of Palaeozoic species have high and frequently nearly globular tests.

In our specimen of *Lepidesthes howsei* the ambulacral plates of the dorsal side are complete from the apical disc to the periphery in area *H*. In areas *B*, *D*, and *F* the dorsal plates of the ambulacra extend from the apical disc to the periphery in part, but with the absence of some plates. In ambulacrum *J*, the dorsal plates are in place only about the adapical portion of the test. These several areas represented by dorsal plates are obviously seen from without, or from the exterior. In the ambulacral areas where the dorsal plates are wanting we have views of the ambulacral plates of the ventral side of the test seen from above, i.e. the internal views of these ventral plates.

In Echini plates as seen from the interior of the test differ somewhat, and often differ essentially, from the very same plates as seen from the exterior, as I have shown elsewhere in both fossil and recent Echini (*Phylogeny of the Echini*). This possibility of difference in the external and internal views must always be borne in mind in considering the character of plates.

Taking up first the ambulacral plates of the dorsal side of *L. howsei*, on the extreme periphery, as shown in area *D* (where they are preserved in a limited area), they are low, wider than high, imbricate strongly adorally, have pore-pairs with rather extra large pores, situated in marked peripodia, and bear two or three small secondary tubercles with minute scrobicules; these are the only tubercles observed on any part of the test. Passing adapically it is seen that the plates rapidly become more crowded, smaller and nearly or quite rhombic in form, the apices of the rhombs being in the vertical and horizontal planes. Throughout the ambulacra the plates of the two median columns are wider than other plates of the area. This is more marked toward the mid-zone and ventrally. In their rhombic character the dorsal plates closely resemble the plates of the dorsal portion of the test in *Lepidesthes colletti*, where they are more clearly defined (*Phylogeny of the Echini*, pl. lxx, fig. 1).

---

[1] There is a specimen of *L. colletti* in the British Museum, E 10,677, which as it is a very rare species, is probably the only one in this country.

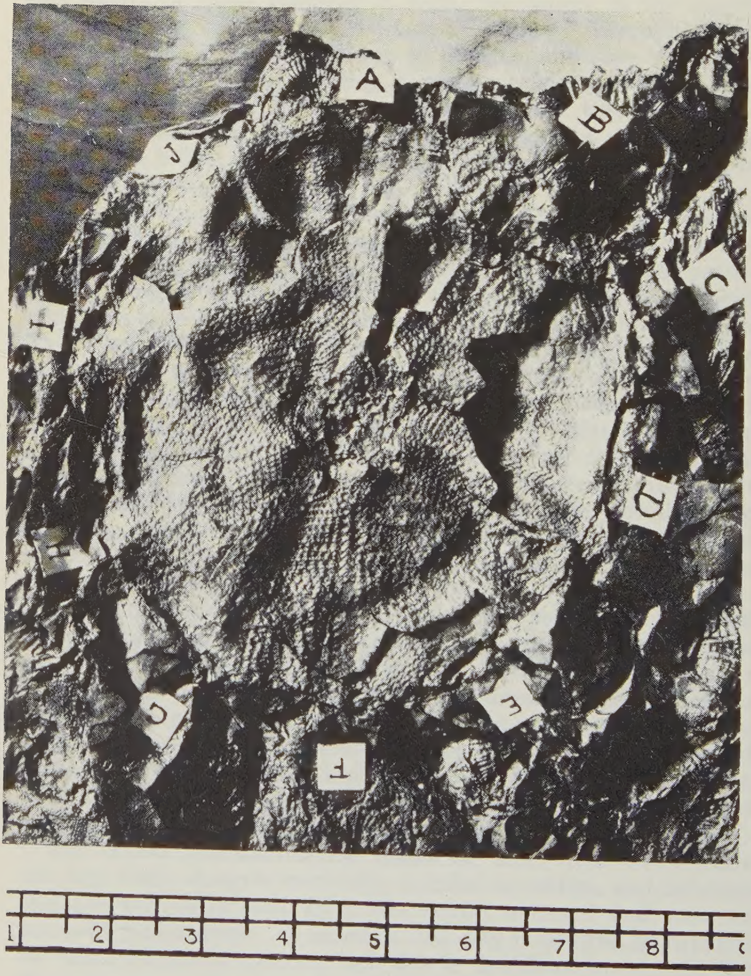
The ambulacral plates of the ventral side in *L. howsei* as seen from within are low, relatively wide, and are more rounded in outline than are those of the dorsal side (seen from without). They present concavely rounded faces adapically, and adorally they dip strongly under (as seen from within) the next adoral plate of their series. The adapical inner and outer tips of the ambulacral ventral plates are produced as spur-like processes which lie over the adoral border of the next adapical plate of their series. This feature is especially marked near the peristomal region and in the plates of the two median columns, and is clearly seen in areas *D* and *J*. The ambulacral pores as seen from within are about central in position and lie near the adoral borders of the plates. The peculiar shape and characters of the ventral plates are without doubt internal characters which would not exist on the exterior of the very same plates.

The dorsal interambulacral plates in our specimen of *L. howsei* are preserved entire from the apical disc to the periphery, or mid-zone, in two areas, *G* and *I*. In area *E* the dorsal plates are preserved in part to the periphery. In areas *A* and *C* they are preserved only near the apical disc. In the areas where the dorsal portion of the test is incomplete, the absence of plates in such parts reveals the interambulacral plates of the ventral side as viewed from above and therefore from within. This is the same condition as prevails in the ambulacral areas.

The dorsal interambulacral plates as seen from the exterior are very scaly, elongate vertically, rounded in outline, and imbricate strongly adapically and from the centre outward and over the adjacent ambulacrals. I failed to find any indication of tubercles on interambulacral plates; but this is doubtless due to the fact that they were very small and easily worn off. The small size would be in accord with what was found in the tubercles of the ambulacral plates and with what is characteristic of interambulacral tubercles in other species of the genus. The interambulacral plates of the ventral side, as seen from above (within) are less rounded and more rhombic in outline than are the dorsal plates

Digitized by the Internet Archive
in 2023

https://archive.org/details/geological-magazine_1926-12_63_12



To face p. 533.]

seen from without. The strong adapical imbrication is very marked, and also the lateral imbrication from the centre outward and over the ambulacrals. Only, as this is an internal view, the plates dip under (not over) adjacent interambulacrals from the centre outward, and also under (not over) the adjacent plates of the ambulacral areas.[1]

In area *A* of our specimen the genital plate is in place and well preserved. It is quite thick and solid, measures 3 mm. in width, by about the same in height, and on the adoral border shows steep bevelling to admit of the adapical imbrication of the subjacent interambulacral plates. This genital plate shows six genital pores clearly preserved. In areas *C* and *E* there are impressions of the genitals, with, in the first case six, and in the second four, vertical plugs which represent casts of the genital pores. In areas *G* and *I* there are partial impressions of genital plates with two, or four to five plugs representing casts of genital pores. None of the genitals can be distinguished as a madreporic plate. Within the periproctal area are some faint impressions that could not definitely be considered as oculars or as plates of the periproct, and yet they may be such.

Taking this specimen of *Lepidesthes howsei* as a whole, it is one of the most interesting cases of a Palaeozoic echinoid that has been discovered in recent years, representing as it does a finely preserved specimen of a genus previously well known only from American formations. It adds interesting information on the character of the interior of the ventral plates, which may or may not be the same in other species of the genus. In structural character *Lepidesthes howsei*, having twelve columns of plates in each ambulacrum, and seven in each interambulacrum, comes after *Lepidesthes carinata*, which also has twelve columns in the ambulacra but only six columns in the interambulacra. It structurally precedes *Lepidesthes colletti*, which has sixteen columns in the ambulacra and either four or five columns of plates in the interambulacra.

As ambulacral plates are the more important feature and are less liable to fluctuation, they are given precedence in considering the status of a species in a genus. Interambulacral plates are considered as of secondary importance, and they may vary in the number of columns in different specimens of the same species, or even in different areas of the same specimen.

DESCRIPTION OF PLATE XXX.

Lepidesthes howsei sp. nov., seen in dorsal view, × $\frac{3}{2}$. A centimeter scale photographed with the specimen shows exact proportions. Letters A, C, E, G, I, indicate interambulacral areas; likewise B, D, F, H, J, indicate ambulacral areas as described.

---

[1] This difference of plates internally and externally and the difference in direction of imbrication is somewhat confusing to explain in studying specimens, but perhaps would be more readily followed by comparing my figures of *Perischodomus*, pl. lxiv, figs. 2, 3, and *Lepidesthes*, text-figs. 32–8, p. 75 (*Phylogeny of the Echini*).

Studies in the Corallian Lamellibranch Fauna of Oxford, Berks, and Wilts.[1]

By W. J. Arkell, B.A., B.Sc., F.G.S.

(PLATES XXXI–IV.)

II. *Pectinidae.*

I. Note as to Measurements and Diagnoses.

THE greatest diameter of a *Pecten* is nearly always the height. It is easier to visualize the size of a shell from this measurement than from the length. Consequently in tabulating the dimensions of the species the height is first given in millimetres, followed by the length as a percentage of the height. Since in the vast majority of the ordinary species the shell is, except for the auricles of the right valve, subequilateral, no obliquity measurement is necessary as with the *Limidae.* Another redundant measurement in dealing with Jurassic *Pectinidae* is the inflation. This dimension is always such a small percentage of the height that accuracy of measurement without special apparatus is a matter of difficulty unless both valves happen to be joined, closed, and free from matrix. Even such differences as do exist can rarely be detected in allied species, such as might be liable to confusion in other respects.

Instead of these last two measurements it is customary to state the Apical Angle. The apex of this angle is the umbo, and the arms form the shoulders of the shell. Since the shoulders are always curved, the angle is measured as close as possible to the umbo, before the curvature begins ; i.e. the angle measured is the minimum apical angle. This angle usually varies between 80° and 110°, and is not of specific value in many of the cases with which we shall deal.

A very important factor in the identification of a *Pecten* is the number, and therefore width and spacing, of the ribs and sulci. Most species have a fixed number of ribs, this number plus or minus one being constant in all but rare and exceptional cases. As the shell grows, however, small secondary ribs sometimes make their appearance erratically in the intervening sulci and on the shoulders at the anterior and posterior ends of the shell. Care must be taken not to count these with the primaries, and for this reason the count should be checked near the umbo. Another form of variation, to which *Chlamys splendens* Dollfus is sometimes liable, is the partial or even total fusion or twinning of some of the primary ribs, which produces an aberration having at first sight an insufficient number of too wide ribs.

An increase or decrease in the number of ribs may sometimes be correlated with horizon ; for instance Sowerby's *Pecten fibrosus* from the Cornbrash has fifteen ribs, whereas the normal form common in the Corallian, identical in other respects, has usually only twelve or thirteen. It is a matter of opinion whether this alone should be regarded as a specific distinction.

---

[1] Continued from Vol. LXIII, p. 210.

II. COMPARATIVE TABLE OF CORALLIAN PECTINIDAE.

	Normal Number of Primary Ribs.	Height of Normal Adult (mm.).	Length. %	Apical Angle.
E. solidum Roem. .	—	55	88	*c.* 94°
C. nattheimensis De Lor	24 ± 1	54	80–90	80°–85°
C. splendens Dollf. .	30–33	65	85–90	85°–90°
C. cf. *blyensis* De Lor. .	38–40	75	85–90	85°–90°
Ca. lens Sow. . .	—	54	93	90°–105°
Ca. giganteus nov. .	—	120	105	105°
A. inaequicostatus Phil.	8	55	98	90°
A. fibrosus Sow. . .	12–13	28	94	90°
A. qualicosta Étall. .	20–25	26	90	85°
V. velatus Goldf. . .	55–70	120	98	*c.* 90°

III. DISTRIBUTION OF THE CORALLIAN PECTINIDAE IN OXFORDSHIRE, BERKSHIRE, AND WILTSHIRE.

	Lower Calcareous Grit.	Headington Shell-cum-Pebble Bed.	Trigonia perlata Limestones.	Urchin Marls.	Pusey Flags.	Coral Rag.
E. solidum Roem. .		—	—			
C. nattheimensis De Lor.			—	⋯	⋯	≡
C. splendens Dollf. .		≡	≡	=	—	=
C. cf. *blyensis* De Lor. .		—				
Ca. lens Sow. . .	—	≡	≡	—	≡	=
Ca. giganteus nov. .		—				
A. inaequicostatus Phil.		—				
A. fibrosus Sow. . .	≡	≡	≡	≡	≡	≡
A. qualicosta Étall. .						—
V. velatus Goldf. . .	=	≡	≡	⋯	⋯	≡

Common ≡ Local = Rare —

IV. Species Known with Certainty to Occur in Oxfordshire, Berkshire, and Wiltshire.

Family Pectinidae.

Genus Entolium.

Sub-genus Entolium Meek, 1864.[1]

Shell rounded, equilateral, not oblique. Valves thin, nearly equal. Sculpture delicate. Auricles well-developed, those of the right valve prolonged dorsally beyond the hinge-line in the form of angular lobes. Byssal notch obsolete. Margin entire.

Entolium solidum Roem., 1836.

Pecten solidus Roemer, 1836, *Versteinerungen*, p. 72, pl. xiii, 7.
Pecten vitreus Roemer, 1836, *Versteinerungen*, p. 212, pl. xiii, 5.
Entolium vitreus De Loriol, 1880, *Zone à Ammonites tenuilobatus d'Oberbuchsiten*, pl. xiii, 3–5.
Entolium vitreus Roeder, 1882, *Terrain à Chailles und seiner Zweischaler in der Umgegend von Pfirt*, p. 56, pl. ii, 2 ; pl. iv, 14.
Pecten demissus Blake & Hudleston, 1877, *Q.J.G.S.*, xxxiii, p. 304.
Non *Pecten demissus* Phillips, 1829, *Geol. Yorks*, pl. vi, 5 (Kelloways Rock) ; non Morris & Lycett, etc.
British Museum Coll. Nos. 47425 (Scarborough, Yorks) ; 23350, 51235 (Malton Oolite, Yorks). (All labelled *E. demissum.*)
Museum of Practical Geology, No. 43088 (Malton Oolite, Yorks, labelled *E. demissum*).

Diagnosis.—Shell obovate, depressed, smooth and shining. Umbones small, acute. Auricles small, equal, with a pronounced dorsal prolongation away from the umbones towards their extremities, their outer borders meeting the margins of the shell at a very acute angle. Apical angle small (*c.* 95°), 15° less than *E. demissum* Phil. Examination of the shining surface with a lens reveals densely crowded, delicate, concentric growth lines, a few of which are conspicuous to the naked eye.

Dimensions of a typical mature specimen (Oxford Univ. Museum Coll., Malton Oolite, Yorks) :—

Height.	Length.	Apical Angle.
68 mm.	88%	94°

Notes.—All the *Entoliums* I have examined from the English Corallian seem to belong to one species, referable with fair certainty to Roemer's *Pecten solidus*, which is now generally agreed to be synonymous with his *P. vitreus*. I follow Staesche (1926) in adopting the former name. Morris and Lycett clearly confused this species with *E. demissum* Phil. (*Great Oolite Mollusca*, p. 128) but the specimen they figure on pl. xiv, 7, is a true *E. demissum* Phil. The Corallian species may be distinguished from the Lower Oolites and Kelloway's *E. demissum* by its more produced, obovate as opposed to suborbicular, shape, smaller apical angle, and the longer, more sloping borders of the auricles, which extend lower down the shoulders than in *E. demissum*, meeting the shoulders at an acuter angle. These differences are best illustrated by the following measurements representing two typical specimens in Oxford University Museum and the author's collection.

---

[1] The classification here adopted is that of Philippi, *Beiträge zur Morphologie und Phylogenie der Lamellibranchier*, II, *Zur Stammesgeschichte der Pectiniden*; Zeitschrift der Deutschen Geol. Gesellschaft, lii, 1900, pp. 64–117. Sub-generic descriptions principally adapted from those of Verrill, *A Study of the Family Pectinidae, with a Revision of the Genera and Sub-genera*; Trans. Connecticut Academy, x, 1899, pp. 41–95.

	Height. mm.	Length. %	Apical Angle.
E. solidum	46	87	95°
E. demissum	45	104	110°

Horizon and Localities.—Shell-cum-Pebble Bed, Headington, and Pebble Bed, Lamb Inn Quarry, Kingston Bagpuize, Berks.

Genus CHLAMYS.

Sub-genus CHLAMYS Bolten, 1798.

Shell high, rounded, somewhat oblique, nearly equivalve. Auricles large, unequal and oblique. A large byssal notch and several pectinidial teeth. Surface strongly sculptured both radially and concentrically, the concentric sculpture often forming rough scale-like projections. Margin scalloped.

Chlamys nattheimensis De Loriol, 1894. (Pl. XXXII, 1–3.)

Pecten cf. *nattheimensis* De Loriol, 1894, *Rauracien Inférieure du Jura Bernois*, p. 52, pl. vi, 4. Non ditto, pl. vi, 6.

Non *Chlamys nattheimensis* Staesche, 1926, *Die Pectiniden des Swäbischen Jura*, p. 42, pl. i, 13, and pl. ii, 2.

Pecten vimineus Phillips, 1871, *Geology of Oxford*, pl. xiii, 20.

Non *Pecten vimineus* Sowerby, 1818, *Min. Conch.*, vol. vi, pl. DXLIII, 1–2.

British Museum Coll. Nos. L. 126, L. 739, L. 3632, L. 20003.

Museum of Practical Geology Nos. Y. 1857, Y. 1863, 43086.

Diagnosis.—Shell medium-sized ; average height about 45–50 mm. Apical angle about 80°. Ornament of right and left valves not widely different. Number of ribs 24 ± 1, resembling rods or strands of wire, usually strong and equal in size, but sometimes twinned and augmented by secondaries.

On the left valve concentric ornament is fine and linear, passing straight over the ribs, but in the sulci tongueing markedly away from the umbo. (This V-shaped tongueing of the transverse lines down the sulci is well shown by De Loriol, pl. vi, fig. 4*a*.) On the ribs every sixth to eighth growth-line develops a projection as it passes over the ribs; this is not spinous, but resembles a finer strand of wire encircling the coarser radial rib. (Paris and Richardson call these "articulations", *Q.J.G.S.*, lxxi, p. 525.)

On the right valve the concentric ornament is as usual finer and less characteristic; the same V-ing of the growth-lines down the sulci is noticeable, however. At about 32 mm. from the umbo in most specimens the ribs begin to lose their rod-like form owing to the closer crowding of the concentric growth-lines, which develop into transverse lamellae pointing towards the umbo on the ribs and away from it in the sulci. In some old age specimens the growth-lamellae again widen out for some 6 to 8 millimetres before finally closing up in a marginal border, in which they are so closely crowded that ribs and sulci are totally obscured by zig-zag lamellae.

The ornament on the auricles is reticulate, but the transverse lamellae predominate, particularly on the left valve.

MATERIAL AND DIMENSIONS.

	Valve.	Number of ribs.	Height. mm.	Length. %
British Museum Collection.				
L. 126. Labelled *P. articulatus*, Schl. Cor. Oolite, Malton, but with soft brown marly matrix . . .	L.	24	57	91
L. 739. Malton Oolite. (Scraped) .	R.	24	41	90
L. 3632. Malton Oolite. . . .	R.	24	—	—
L. 20003. Corallian, Malton. J. F. Blake Coll. Labelled *P. vimineus*. Bad specimen	—	*c.* 24	49	85½
24685 Hinton, Trowbridge, green clay matrix; labelled *P. articulatus* .	L.	24	55	84
Museum of Practical Geology.				
Y. 1857. Ayton, Yorks. . . .	L.	24	54	83½
Y. 1863. Ashdale, Helmsley, Yorks .	L.	24	47	—
43086. Littlemore Clay Beds, Hillmarton, Wilts. Labelled *P. articulatus*. Double valves; umbones missing	L. & R.	25	—	—
Oxford University Museum.				
(i) Coral Rag, Headington. Umbo missing. Labelled *Pecten episcopalis*	L.	25	*c.* 44	80
(ii) Coral Rag, Cumnor. Umbo missing	L.	24	*c.* 46	78½
Author's Collection.				
(i) Coral Rag, Shellingford Cross Roads Quarry, Berks	R.	23	41	—
(ii) Coral Rag, Shellingford Cross Roads Quarry, Berks.	R.	25	50	86
(iii Coral Rag, Botany, Highworth. Umbo missing	—	*c.* 23	*c.* 46	—

Notes.—The above thirteen specimens, besides agreeing closely in the number of ribs and measurements, are at once proclaimed to belong to the same species as De Loriol's *P. nattheimensis* by the V-shaped tongueing of the concentric growth-lines down the sulci (Pl. XXXII, Fig. 2). Owing to the mode of preservation among the corals perfect specimens from this district are rare, but fragmentary examples are abundant throughout the Coral Rag, and they always agree in these characters.

The supplementary fragment figured by De Loriol (op. cit., pl. vi, figs. 6 and 6*a*) has only twenty ribs, and the concentric growth-lines cross the sulci without appreciably tongueing away from the umbo. It therefore agrees with the *Chlamys articulatus*, Goldf. non-Schlot. group (which see).

Staesche (op. cit., p. 42) gives a long synonymy for *Chlamys nattheimensis*, including *Pecten articulatus* Goldf., Quenstedt and Oppel (non Schlot.), *P. nisus* D'Orb., *P. nosus* D'Ob., *P. bourgeati* De Lor, etc. ; but his figures do not agree with De Loriol's. From his pl. ii, 2, it is obvious that the specimen figured differs from De Loriol's species in (i) having only twenty ribs, (ii) the fact that the concentric growth-lines do not tongue down the sulci, (iii) the fact that the projections formed by the transverse lamellae on the ribs are more widely spaced and coarser, tending to become spinous. The specimen figured on pl. i, fig. 13 (the type of Quenstedt's *P. articulatus*) is too bad to show details, but it has only eighteen or nineteen ribs.

On these grounds, then, Staesche's identification of *Chlamys nattheimensis* with Goldfuss', Quenstedt's, Oppel's, Roemer's, and D'Orbigny's *P. articulatus* cannot be accepted. While he is probably right in grouping the latter together, they constitute an eighteen–twenty ribbed species more comparable with *Chlamys viminea* Sow., from which they differ, however, in their narrower shape and much coarser transverse ornament on the right valve (as pointed out elsewhere by Staesche).[1]

If Staesche's identification of this species with *Pecten nisus* D'Orb. (1850) is right, it should stand under that name (since Schlotheim's original *P. articulatus* has now been found to be a totally different species belonging to the *vagans* group ; see *P. articulatus* in list at end of paper). Morris and Lycett's Cornbrash "*P. articulatus*", which Staesche includes in his synonymy, is a different species altogether.

Horizon and Localities.—Chlamys nattheimensis is the common Coral Rag *Pecten* of Oxford, Berks, and Wilts, known hitherto as *Pecten articulatus* and *Pecten vimineus.* It abounds wherever there are reef corals, comprising with *Lima zonata* Ark. an important element of the "Coral Fauna". It also occurs with this fauna in the small local reefs of Trigonia Bed age, near Highworth, where it is, however, comparatively rare and associated with an abundance of *C. splendens* Dollf.

Chlamys splendens Dollfuss, 1863. (Pl. XXXI, Figs. 1–4.)

Pecten splendens Dollfuss, 1863, *La Faune Kimméridgienne du Cap de la Hève*, p. 78, pl. xiv, 7–9.

---

[1] Compare the right valves figured by Goldfuss, *Petrefacta*, pl. xc, 10, and Sowerby, *Min. Conch.*, vol. vi, pl. DXLIII, 2.

Chlamys cf. *episcopalis* Staesche, 1926, *Die Pectiniden des Swäbischen Jura*, pl. ii, 3.

Non *Pecten episcopalis* De Loriol, 1894, *Rauracien Inf. du Jura Bernois*, p. 50, pl. vi, 1–2.

? *Pecten episcopalis* De Loriol, 1904, *Oxfordien Sup. et Moy. du Jura Ledonien*, p. 223, pl. xxiv, 7.

? *Pecten subtextorius* Blake & Hudleston, 1877, *Q.J.G.S.*, xxxiii, p. 402.

Non *Pecten subtextorius* Goldfuss, *Petrefacta Germaniae*, p. 48, pl. xc ; non D'Orbigny, Oppel, Quenstedt, Staesche, etc.

British Museum Coll. Nos. L. 723, 23356 (*a* and *b*), L. 18153, 24561, 24501, L. 19977.

Museum of Practical Geology, No. 43087.

Diagnosis.—Shell large ; average height of full-grown specimens over 65 mm. Apical angle 85°–90°. Ribbing and ornament of right and left valves almost identical. Number of ribs about thirty to thirty-three, of unequal size, sometimes twinned, but not bifurcating.

Concentric ornament consists of numerous rather small lamellae, which become slightly spinous on the ribs at about 32 mm. from the umbo (see Pl. XXXI, Fig. 2). The sulci are smooth, bearing only very faint transverse linear ornament V-ing away from the umbo.

Anterior and posterior auricles of the right valve differently ornamented. About seven radial costae are predominant on the posterior auricle. On the anterior auricle the dominant ornament consists of numerous transverse undulating lamellae, giving rise to a reticulate pattern. The same difference exists to a lesser extent in the auricles of the left valve.

MATERIAL AND DIMENSIONS.

	Valve.	Number of ribs.	Height. mm.	Length. %
Holotype	L. & R.	30–31	*c.* 74	*c.* 93
British Museum Coll.				
L. 723. Malton Oolite	L.	*c.* 31	64	87½
23356 (*a*) Malton Oolite . . .	R.	*c.* 32	64	90½
23356 (*b*) Malton Oolite . . .	R.	*c.* 31	65	90
L. 18153, Headington, Shell-cum-pebble Bed. (All these labelled *P. vimineus*)	R.	33	63	89
24501, labelled " *P. articulatus*, Calc. Grit "	L.	*c.* 31	47	85
L. 19977, Hillmarton, J. F. Blake Coll.	L.	31	41	85
Museum of Practical Geology.				
43087. " Oxford." Shell-cum-Pebble Bed : labelled *P. articulatus* . .	L.	32	—	—
	R.	31		
Oxford University Museum.				
(i) Unlabelled. Matrix of Shell-cum-Pebble Bed. Only inside showing .	R.	*c.* 30	78	88½
(ii) Marcham. Young specimen labelled *P. subtextorius*	R.	31	27	84

	Valve.	Number of ribs.	Height. mm.	Length. %
(iii) " 2¼ m. W.N.W. of Abingdon." Shell-cum-Pebble Bed ? (Unusually smooth specimen, but ornament normal on auricles) . . .	R.	31	64	87½
Author's Coll.				
(i) Coral Rag, Horspath Road, Cowley .	R.	33	*c.* 66	*c.* 92
(ii) Trigonia-Bed Limestones, Hangmans Elm Quarry, Highworth .	R.	30	65	86
(iii) Urchin Marls, Shellingford . .	R. & L.	31	66	92
(iv) Shell-cum-Pebble Bed. Headington	R.	31	*c.* 55	—
(v) Urchin Marls, Marcham . .	L.	31	39	84½
(vi) Urchin Marls, Marcham (var.) .	—	*c.* 34	—	—

Notes.—The characters of the above fourteen specimens are too constant to admit of any doubt that they belong to a single well-defined species. In addition I have recognized large numbers of fragmentary specimens in the field, all comformable in every respect to those enumerated. Occasional departures from the usual number of ribs occur, such as (vi) above, in which some of the ribs are finer than usual, and taper off into yet more secondaries on the shoulders ; in another specimen in the British Museum the number is reduced below the normal by the fusing together of some of them to form double or twinned ribs.

In spite of the four names under which this species has been recorded, I know of no record of *C. splendens* Dollfuss from the English Corallian ; yet within the limits of a drawing Dollfuss' figures represent our species almost exactly, in dimensions, form, number of ribs, apical angle, and ornament. The ribs are perhaps slightly wider and the sulci slightly narrower, but without being able to examine the holotype I do not feel justified in making this a specific difference. Although Dollfuss' specimen was obtained from the Lower Kimmeridge of Havre, his work contains figures of several species familiar in the English Corallian, e.g. *Littorina pulcherrima*, *Unicardium excentricum*, *Arca laura*, *Myoconcha saemanni*, *Pecten intertextus*, and *Lima lepida*, which is very closely allied to our *Limatula elliptica*.

The specimen in Oxford University Museum from near Abingdon (No. iii) agrees well with the smooth shell figured by Staesche as *Chlamys* cf. *episcopalis* De Lor. (loc. cit.). They have at least thirty ribs, however, and measure respectively 64 mm. and 59 mm. in height. They therefore differ widely from De Loriol's original figures of *C. episcopalis* (1894, loc. cit.), which has twenty-four to twenty-five ribs and measures only from 37 mm. to 50 mm. in height. The specimen figured under the same name by De Loriol ten years later from a lower horizon (1904, loc. cit.) is probably that from which Staesche made his identification, for it has thirty ribs and is worn smooth. In spite of the statement by De Loriol (p. 223) that the specimens before him agree so exactly with his others formerly described that he does not deem it worth while repeating the description, the specimen figured belies the statement and may with all probability be regarded as a different species. It is too small for a normal *C. splendens*, but may be a young individual or belong to a dwarfed local race.

Chlamys splendens differs from its nearest allies in the following respects.

(i) From *C. viminea* Sow., *C. episcopalis* De Lor., *C. nattheimensis* De Lor., *C. articulata* Goldf., etc., non Schlot., *C. quenstedti* Blake, in its greater number of ribs, and from all but the last also in its greater size.

(ii) From *C. subtextoria* Goldf. in its ornament, the smaller number of its more widely-spaced ribs, and it much greater size.

(iii) From *C. blyensis* De Lor. in its ornament, the smaller number of its ribs, and its narrower or more produced shape.

Horizon and Localities.—Abundant in the Berkshire Oolites, where it is the commonest *Chlamys*, but also occurring in association with *C. nattheimensis* De Lor. in the Coral Rag. Common in the Malton Oolite, Yorkshire.

Chlamys cf. *blyensis* De Loriol, 1902. (Plate XXXIII, Figs. 2–3.)

Pecten (*Chlamys*) *blyensis* De Loriol, 1902, *Oxfordien Supérieure et Moyen du Jura Ledonien*, p. 224, pl. xxiv, 3–4.

Diagnosis.—Shell large and almost sub-orbicular; ribs 38–40 in number, separated by smooth sulci. Height (max.) 66 mm. Length (max.) 54 mm. For further details see De Loriol, loc. cit.

Material.—A single specimen, probably referable to this species, in Oxford University Museum, labelled Bullingdon; matrix gritty limestone, probably Shell-cum-Pebble Bed.

Height.	Length.	Apical Angle.	Number of ribs.
77 mm.	85%	85°	38+

The ribs are very unequal and unevenly spaced. Besides the thirty-eight primaries, there are in some of the intervening spaces a few fine secondaries which do not reach half-way to the umbo. The ribs are very bare of transverse ornament, and widely set apart (see Pl. XXXIII, Fig. 3). The concentric ornament is divided into four zones. (i) Reticulate on tip of umbo; (ii) totally absent up to about 40 mm. from umbo; (iii) 40–65 mm., widely spaced and spinuous on the ribs, but smooth in the sulci (Pl. XXXIII, Fig. 3); (iv) 65 mm. to the margin (77 mm.), closely crowded, undulating, linear, equal on the ribs and sulci, tongueing towards the margin in the sulci and towards the umbo on the ribs.

From the appearance of the ornament, I presume this to be a left valve, but the posterior auricle (in that case) is missing.

Notes.—This identification is only provisional, pending the discovery of more material. I hesitate to found a new species on a single specimen.

Horizon and Locality.—Berkshire Oolites, Bullingdon, near Oxford.

Sub-genus CAMPTONECTES Meek, 1864.

Shell subovate, plain, devoid of corrugations or strong radial ribs. Valves subequal. Auricles unequal; byssal notch well developed. Surface of the shell ornamented with fine, obliquely divergent, curved, crenulated or vermiculated riblets with intervening narrow, punctate grooves. Margin entire.

Camptonectes lens Sowerby, 1818.

Pecten lens Sowerby, 1818, *Mineral Conchology*, vol. iii, pl. ccv, 2–3. Two syntypes and a third specimen in Sow. Coll., Brit. Mus., labelled " F. M. near Oxford ", matrix Corallian.

Pecten arcuata Sowerby, 1818, *Min. Conch.*, vol. iii, pl. ccv, 5, 7. Two syntypes, Sow. Coll., Brit. Mus., Coral Rag, Devizes.

Pecten similis Sowerby, 1818, *Min. Conch.*, vol. iii, pl. ccv, 6. Holotype, Sow. Coll., Brit. Mus., Corallian, Shotover Hill, Oxford.

Pecten lens Goldfuss, 1834–40, *Petrefacta Germaniac*, pl. xci, 3.

? *Pecten lens* Morris and Lycett, 1850, *Great Oolite Mollusca*, p. 11, pl. ii, 1.

Pecten zieteneus Buvignier, 1852, *Geol. de la Meuse*, p. 24, pl. xix, 24–25.

Pecten lens Phillips, 1871, *Geology of Oxford*, pl. xiii, 24.

British Museum Coll. Nos. 23353, 47416, 23358, L. 3635, (all from the Malton Oolite).

Diagnosis.—Shell suborbicular. Ornament of both valves consists of closely set, fine, curved, radiating or obliquely-divergent lines, often bifurcating, densely punctate, rendered reticulate to a varying degree by fine concentric growth-lines.

Dimensions of a typical mature individual :—

Height. mm.	Length. %	Apical Angle.
54	93	106°

Notes.—Sowerby's two syntypes are said to be " a produce of the forest marble near Oxford " (loc. cit.). An inspection of the specimens in the British Museum, however, fails to reveal any differences separating them from the shells so common in the Oxford Corallian ; the matrix confirms this, for it can definitely be said to be the Shell-cum-Pebble Bed of Headington, a rock easily recognized by those familiar with it. A possible explanation of this occurs on the next page, under the heading of *Pecten similis* ; this is said to be " Upon shelly Limestone, probably belonging to the Forest Marble, from Shotover Hill, Oxford ". As everybody knows, there is no Forest Marble within miles of Shotover Hill, which is, on the other hand, surrounded by the Corallian with its shelly limestone full of *Camptonectes lens.* Whether this is the correct explanation or not, I prefer for the present to avoid assuming that all the species of *Camptonectes* described by Sowerby from various levels in the Lower

Jurassic (*P. laminatus*, *P. obscurus*, *P. annulatus*) belong to the same species, as has been done by Staesche (op. cit., p. 76). Such an assumption seems hardly safe without further research. The only other British *Pecten* which could be claimed to have such a long time-range is *P. inaequicostatus*, an unsatisfactory instance, for the species is so variable that hardly any two specimens are alike, and it is only on that account that the differences correlated with various horizons have been thought to lay claim to scarcely more specific significance than those between individuals from the same horizon.

Sowerby's *P. arcuata* and *P. similis* agree with Buvignier's *P. zieteneus* in having an apical angle of only 90°–95°. I have found a similar specimen in the Pebble Bed of Littleworth, Berks, and intermediate forms occur, so that they probably constitute only a variety.

Horizon and Localities.—Throughout the Corallian. Particularly common in the Berkshire Oolites.

Camptonectes giganteus sp. nov. (Pl. XXXIII, Fig. 1.)

Four syntypes in Oxford University Museum.

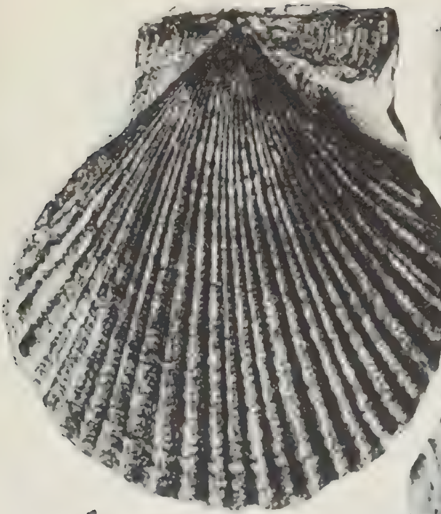
British Museum Coll. No. L. 405 (Malton Oolite, Yorkshire).

Diagnosis.—Shell very large, suborbicular, subequilateral. Left valve moderately convex, right valve nearly flat. Radial ornament consists of irregular, interrupted, fine, obliquely-divergent lines, curving upwards fanwise at the sides of the shell, as in *C. lens*. These are crossed at very irregular intervals by fine concentric growth-lines. The ornament is, however, predominantly radial and essentially irregular, differing in this respect from the regular, punctate-reticulate ornament of *C. lens*. Punctae are confined to the umbones. The ornament fades towards the centre of the shell in both valves, leaving the whole central region, including that close to the margin, smooth. That this is not due to abrasion in old age is shown by its occurrence in young specimens measuring only 83 mm. in height. The right valve is mainly smooth, ornament being confined to the shoulders.

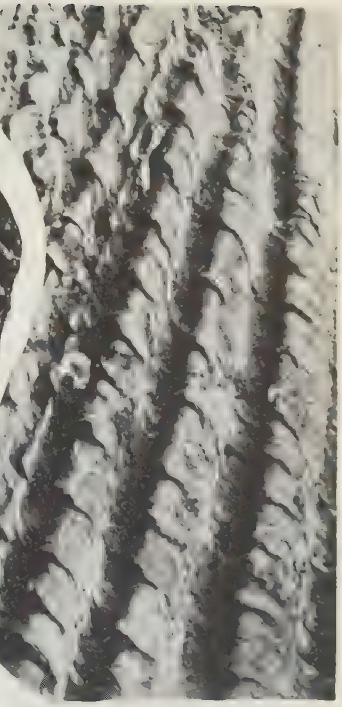
Auricles covered with strong transverse lamellae, which obscure a system of fine longitudinal grooves.

Material and Dimensions.—Four syntypes from the Shell-cum-Pebble Bed near Oxford, all in Oxford University Museum.

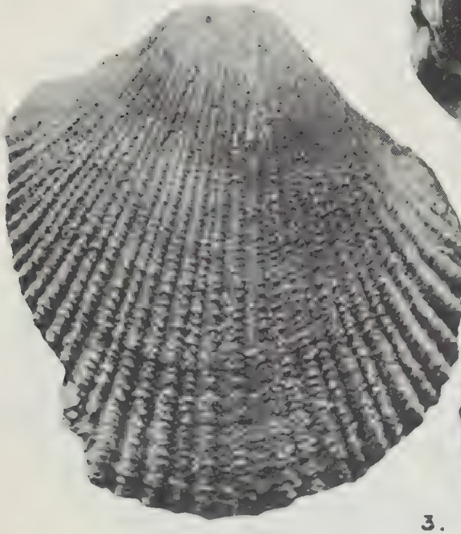
	Valve.	Height.	Length.	Apical Angle.
(i) Kennington, Oxford . . .	R.	—	100 mm.	*c.* 105°
(ii) Littlemore, Oxford. Young individual	R.	83 mm.	83 mm. (100%)	105°
(iii) Headington, Oxford . .	L.	112 mm.	113 mm. (101%)	*c.* 105°
(iv) Windmill Quarry, Headington .	L.	125 mm.	132 mm. (106%)	—
B.M. Coll. L. 405, Malton Oolite, Yorks, labelled *P. arcuatus* .	L.	85 mm.	*c.* 82 mm. (97%)	*c.* 105°



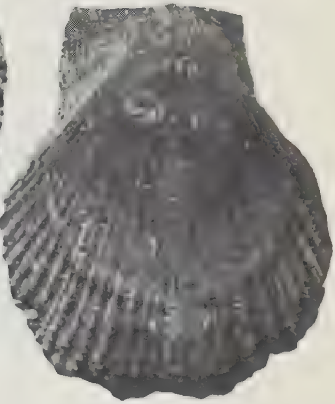
1.



2.



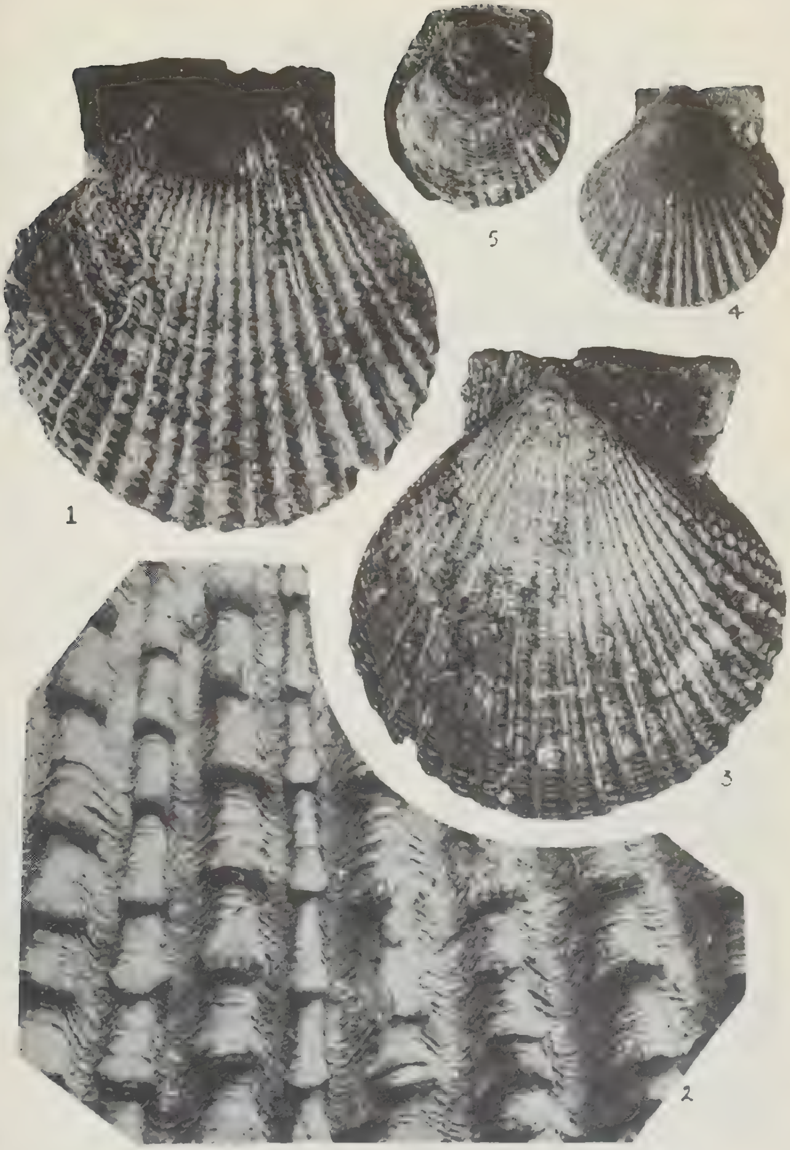
4.



3.

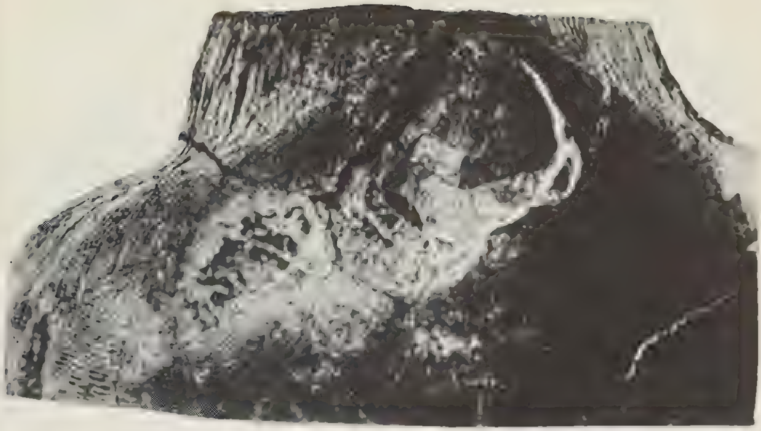
CORALLIAN PECTINIDAE.

FIGS. 1–4.—*Chlamys splendens* Dollfuss.



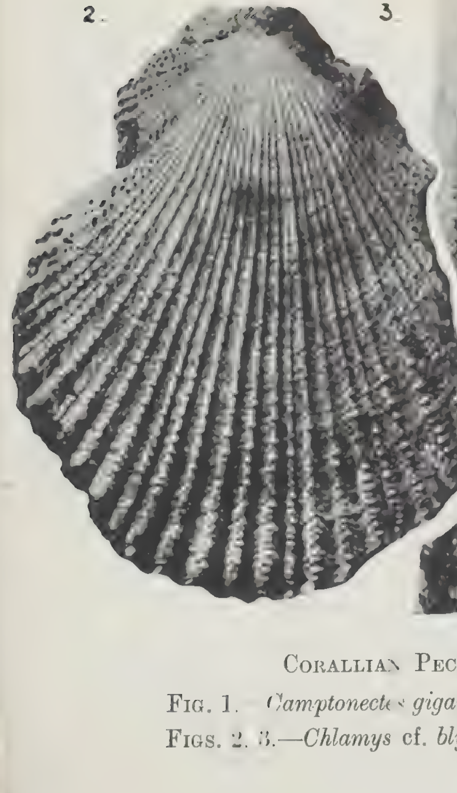
CORALLIAN PECTINIDAE.

FIGS. 1–3.—*Chlamys nattheimensis* De Loriol.
FIGS. 4, 5.—*Aequipecten qualicosta* Étallon.

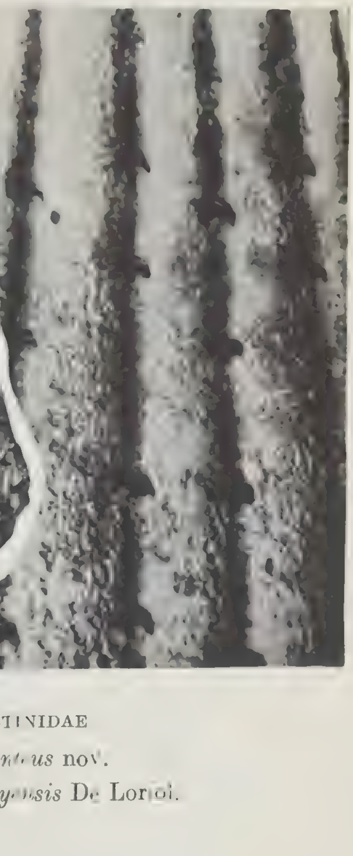


1

2.



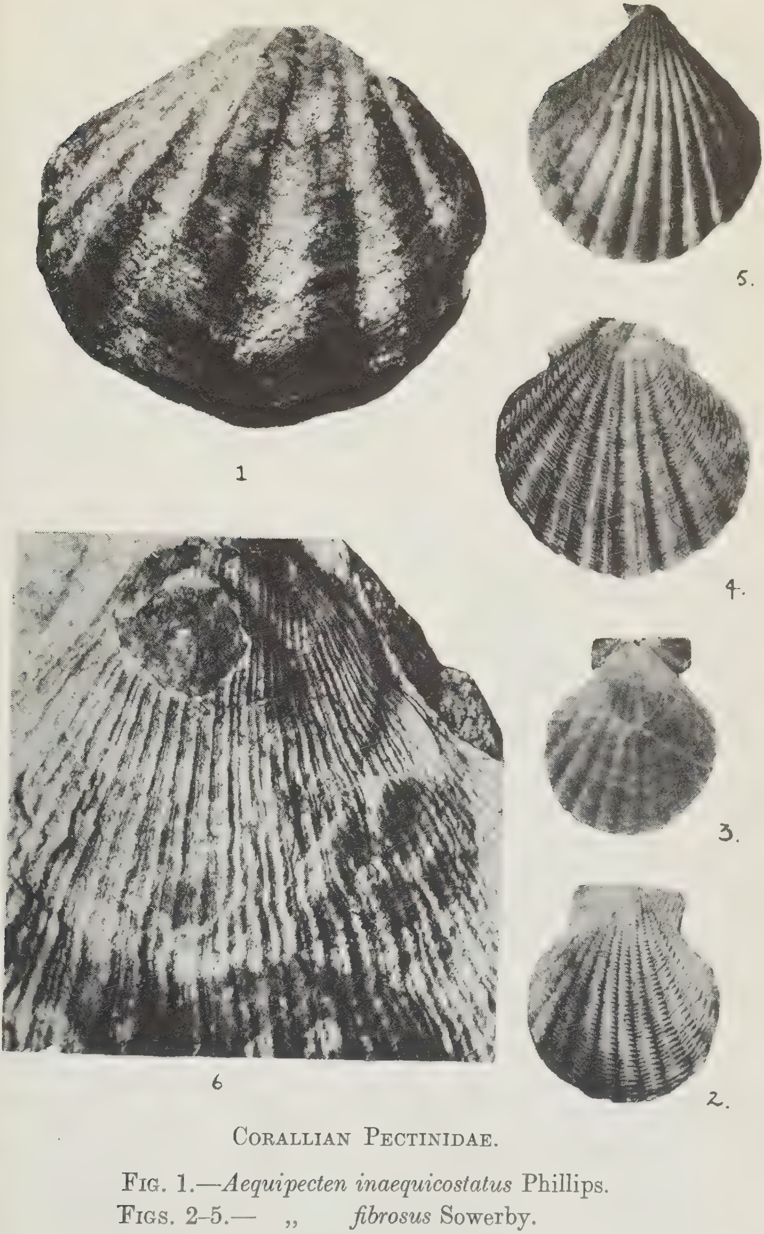
3.



CORALLIAN PECTINIDAE

FIG. 1.—*Camptonectes giganteus* nov.

FIGS. 2, 3.—*Chlamys* cf. *blyensis* De Loriol.



CORALLIAN PECTINIDAE.

FIG. 1.—*Aequipecten inaequicostatus* Phillips.
FIGS. 2–5.— ,, *fibrosus* Sowerby.
FIG. 6.—*Velopecten velatus* Goldfuss.

Notes.—The gigantic size of these specimens constitutes their first claim to rank as a separate species. *Camptonectes lens*, Sow., is exceedingly common in the district, yet the largest specimen known to me has a height of only 56 mm. The commonest size is about 40–55 mm. That the specimens above are not merely freaks is shown by the differences of ornament mentioned in the diagnosis and by their greater length in proportion to height; that the smoothness of the centre of the shell is not due only to abrasion is shown by its occurrence in the young specimens.

The large specimen figured by Staesche under *C. lens* (*Die Pectiniden des Swäbischen Jura*, pl. ii, 8), though its size suggests that it may belong to this species, is not so large as the smallest of our specimens and has ornament agreeing more with the normal *C. lens*, of which it is probably a gerontic form.

Horizon and Localities.—So far only the four syntypes known, from the Shell-cum-Pebble Bed of Headington, Littlemore, and Kennington, and the one left valve in the British Museum from the Malton Oolite, Yorks.

Sub-genus AEQUIPECTEN Fischer, 1887.

Shell broadly rounded, subequivalve, subequilateral, the valves differently ornamented. Auricles well developed, angular; marked byssal notch present. Sculpture consists of a moderate number of large and nearly equal primary radial ribs, increasing greatly in size with age, but not bifurcating or becoming augmented in number. Hinge-plate with one or two slightly divergent ribs at each end. often crossed by strong transverse incisions. Pectinidial teeth generally present. Margin scalloped.

Aequipecten inaequicostatus Phillips, 1829. (Pl. XXXIV, Fig. 1.)

Pecten inaequicostatus Phillips, 1829, *Geology of Yorkshire*, p. 129, pl. iv, 10.

Pecten octocostatus Roemer, 1836, *Versteinerungen*, p. 69, pl. iii, 18 = *Pecten septemcostatus* Roem., ibid., p. 215.

Pecten octocostatus Thurmann and Étallon, 1862, *Lethea bruntrutana*, p. 252, pl. xxxv, 7.

Pecten inaequicostatus De Loriol, 1892, *Couches Coralligènes Inf. du Jura Bernois*, p. 301, pl. xxxii, 13–15.

Non *Pecten inaequicostatus* Morris and Lycett, 1850, *Great Oolite Mollusca*, p. 32, pl. xxxiii, 1, 1*a*.

British Museum Coll. Nos. 23347, 23359, 23363, 23173 (all from the Malton Oolite, correctly labelled).

Museum of Practical Geology, Nos. Y. 1967, Y. 1968 (Hudleston Coll., Settrington, Yorks).

Diagnosis.—Shell medium-sized to rather large, thrown into seven or eight large, coarse plications or ribs, those in the centre very much coarser than those at the sides. On the right valve the ribs are flat-topped and wider than the intervening sulci, which are concavely rounded and project at the margin farther ventrally than the ribs. On the left valve the sulci are wide and flat, and the ribs narrower and convexly rounded, projecting at the margin farther ventrally than the sulci. The two valves thus have a very different appearance; besides this the species is extremely variable, scarcely two specimens being found alike.

Both valves are covered irregularly by coarse and fine concentric growth-lines.

Dimensions of a typical mature specimen :—

Height. mm.	Length. %	Apical Angle.	Number of ribs.
57	98	90°	8

Notes.—The above diagnosis is made from topotypes of Phillips' *Pecten inaequicostatus*, and brings out the essential characters of the English Corallian form. Of the Cornbrash form figured by Morris and Lycett (loc. cit.) the left valve agrees fairly well except that the costae do not begin for some distance from the umbo; but the right valve is too flat, the sulci are too narrow and insufficiently pronounced, and do not project ventrally beyond the costae.

Horizon and Localities.—Only a single specimen known from these counties, a right valve in Oxford University Museum from the Shell-cum-Pebble Bed of Headington. Common in the Coralline Oolites of Yorkshire.

Aequipecten fibrosus Sow., 1818. (Pl. XXXIV, Figs. 2–5.)

Pecten fibrosus Sowerby, 1818, *Mineral Conchology*, vol. ii, p. 84, pl. cxxxvi, 2. Two syntypes in the British Museum.

Non *Pecten fibrosus* Phillips, 1829, *Geol. Yorks*, pl. vi, 3 (Kelloways Rock).

Pecten fibrosus Deshayes, 1831, *Coquilles caractéristiques des terrains*, p. 82, pl. viii, 5.

Pecten fibrosus Goldfuss, 1834–40, *Petrefacta Germaniae*, p. 46, pl. xc, 6.

Pecten subfibrosus D'Orbigny, 1850, *Prodrome*, pt. i, p. 373.

Pecten subfibrosus Roeder, 1882, *Terrain à Chailles in der Umgegend von Pfirt*, p. 49, pl. i, 12*a–d*.

Non *Pecten fibrosus* Roeder, ibid., pl. i, 11*a–b* (cf. *P. vagans* Sow.).

Pecten subfibrosus De Loriol, 1894, *Rauracien Inf. du Jura Bernois*, p. 45.

Non *Aequipecten fibrosus* Philippi, 1900, *Zeit. Deutsch. Geol. Gesell.*, lii, p. 98, fig. 15. (*P. vagans* Sow.)

British Museum Coll. Nos. L. 749, 23357, 34407 (all from the Malton Oolite, Yorks), L. 1220, L. 3615, 47436 (labelled *P. vagans*), (all from Scarborough, Yorks), L. 20205 (Nothe, Weymouth, J. F. Blake Coll.), three unnumbered left valves from Weymouth in exhibition cases.

Diagnosis.—Shell rather small, thrown into from twelve to fourteen conspicuous radial plications or ribs. Right and left valves very dissimilar.

On the right valve the ribs are rather flat-topped and wider than the sulci, which are concavely rounded. In the sulci very fine radial striations are perceptible, and ribs and sulci alike are crossed by closely-crowded, fine concentric growth-lines. This secondary ornament is so fine, however, that the right valve appears smooth but for the primary radial ribs or plications.

On the left valve the sulci are flat and of equal width or wider than the ribs, which are narrow and convexly-rounded. The latter appear no longer as plications, but as abrupt wire-like ribs standing out sharply from the general surface of the shell. The sulci bear the same fine radial striations as on the right valve, and in some large varieties these become more conspicuous, so as almost to suggest incipient secondary ribs. The concentric growth-lines, instead of being fine and inconspicuous as on the right valve, stand out as conspicuous lamellae, crossing both ribs and sulci alike and passing on to the auricles. Where these intersect the radial striae in the sulci a faint secondary reticulate pattern is formed.

Dimensions of typical Corallian specimen :—

Height. mm.	Length. %	Apical Angle.	Number of ribs.
30	94	90°	13

Notes.—Of the two syntypes the larger came from the Cornbrash of Chatley. It is a large right valve having two more ribs than is usual with Corallian specimens, but since the latter vary in this respect, whereas the specimen agrees with them in all other respects, it may possibly be regarded as a variety. The smaller specimen, a left valve from the Corallian of Oxfordshire, unfortunately displays only its inner surface, the outer surface being imbedded in matrix. It is this fact that has given rise to the misapprehensions regarding Sowerby's species among continental authors. De Loriol wrote in 1894 (*Rauracien Inf. Du Jura Bernois*, p. 46) : " Je n'ai vu aucun exemplaire du *Pecten fibrosus* typique des auteurs anglais, et une description complète de cette espèce, avec de bonnes figures, est très désirable." This want I hope the present paper supplies.

The first interpretation of Sowerby's species was by Deshayes, 1831 (loc. cit.). The interpretation appears to have been perfectly correct, and a right valve was figured bearing fourteen ribs. Deshayes was followed by Goldfuss and other authors until 1850, when D'Orbigny in the *Prodrome*, feeling doubts about Sowerby's species, of which he was ignorant of the left valve, thought fit to change the name of the species of the continental authors to *P. subfibrosus*. This practice has been followed by continental authors ever since, who write *P. subfibrosus*, or *P. fibrosus* Deshayes non Sow., when in reality Deshayes' and Sowerby's species are identical. Roeder's interpretation of the " real " *P. fibrosus* Sow. (loc. cit.) is very wide of the mark, as was suspected by De Loriol (1894, op. cit., p. 47). Philippi's species (loc. cit.) has paired ribs in the right valve, a feature characteristic of *P. vagans* Sow.

Variation.—The variation in respect of the number of ribs has already been mentioned. The usual number for Corallian specimens is twelve or thirteen. Deshayes' figure has fourteen, and one of Sowerby's (from the Cornbrash) fifteen; when the palaeontology of the Cornbrash comes to be worked out it may be convenient to give the latter a separate name to distinguish it from the Corallian form.

There is considerable variation in size. The average height of mature Corallian specimens is about 26–30 mm. A large local race exists in the Shell-cum-Pebble Bed of Headington, in which specimens up to 38 mm. are common. The largest specimen known is a right valve in the British Museum from the Malton Oolite, measuring 40 mm. in height. In the left valve of these large specimens the spaces between the ribs widen and incipient secondary ribs begin to appear, as if foreshadowing *Pecten midas* Dollfuss, of the Sandsfoot Grits and Kimmeridgian.

Horizon and Localities.—After *Exogyra nana* this is probably the commonest Lamellibranch in the English Corallian, occurring from the base to summit as high as the Osmington Oolite Series.

Aequipecten qualicosta Étallon, 1861–3. (Pl. XXXII, Figs. 4–5.)

Pecten qualicosta Thurmann and Étallon, 1861–3, *Lethea bruntrutana*, pl. xxxvi, 13.

Pecten qualicosta Blake and Hudleston, 1877, "The Corallian Rocks of England," *Q.J.G.S.*, xxxiii, p. 402, pl. xv, 4, 4*a*.

British Museum Coll. Nos. 34423 (Malton Oolite, Yorks), J. F. Blake Coll. Nos. L. 19972 (Stourside, near Preston, Dorset), L. 20224, L. 20226 (two left valves both from the Calne Oolite, Calne Workhouse Quarry, Wilts).

Diagnosis.—Shell small, rarely exceeding 28 mm. in height; shaped like a *Chlamys*, but having the ornamentation of the *Aequipecten fibrosus* group.

The radial ribs are so irregular that division into primaries and secondaries is arbitrary and counting consequently unreliable. In some specimens there is a certain alternation of large and small, but in others the ribs are of all sizes and devoid of orderly arrangement. Both valves bear from twenty to thirty ribs. In the left valve the ribs are ornamented as in the left valve of *A. fibrosus* by numerous fine transverse or concentric lamellae, which are sometimes present also in the right valve; on the latter, however, they are usually represented by fine concentric lines, as in *A. fibrosus*.

Auricles as in *A. fibrosus*.

Dimensions of a typical mature individual:—

Height. mm.	Length. %	Apical Angle.	Number of ribs.
26	90	85°	20–25

Notes.—The specimens I have examined agree well with Blake and Hudleston's figures, but the figures in *Lethea bruntrutana* are not sufficiently good to dispel all doubts that *Étallon's* species has been rightly identified. I leave the responsibility for the identification therefore to Blake and Hudleston. *Pecten varians* Roem. is very closely allied, but has about thirty-four ribs in the right valve (see *Versteinerungen*, pl. iii, fig. 19); the left valve was not figured. There are probably several undescribed allied species, one of which is figured by Philippi under the name *P. varians* Roem., which it certainly is not, as it has about twice the number of ribs in the right valve. (*Zeit. der Deut. Geol. Gesell.*, lii, p. 99, fig. 16*a*.) The left valve (if it belongs to the same species) has only about twenty-eight ribs, and much resembles our *P. qualicosta* (ibid., fig. 16*b*).

Horizon and Localities.—Common in the Calne Oolite (of Coral Rag age), and I have found it rarely in the Coral Rag at Wootton, Berks. Blake and Hudleston record it from the Trigonia Bed of Kington Bagpuize, but careful search has convinced me that this is an error and that it does not appear below the Osmington Oolite Series (Coral Rag).

Genus VELOPECTEN Quenstedt, 1858, Philippi, 1898, Staesche, 1926 = EOPECTEN Douvillé, 1897, Paris and Richardson, 1915.

Shell large, inequivalve, oblique, variable in shape. Right valve flat, left valve convex (the opposite to *Hinnites*). Right valve with deep byssal notch; left valve bearing very large anterior auricle, not clearly differentiated from the anterior umbonal region of the shell, greatly exceeding the posterior auricle in size. Strong radial ornament, the ribs often interrupted or knotted by irregular concentric growth-lines.

Velopecten velatus Goldfuss, 1834–40. (Pl. XXXIV, Fig. 6.)

Spondylus velatus Goldfuss, 1834–40, *Petrefacta Germaniae*, p. 94, pl. cv, 4*a*, *b*.

Non *Pecten velatus* Goldfuss, ibid., p. 45, pl. xc, 2.

Non *Hinnites velatus* Morris and Lycett, 1850, *Great Oolite Mollusca*, pl. ii, 2.

Hinnites abjectus Whiteaves, 1861, "The Palaeontology of the Cor. Oolites in the Neighbourhood of Oxford," *Ann. Nat. Hist.*, viii, 1861, list, p. 143.

Non *Hinnites abjectus* Phillips, 1829, *Geol. Yorks*, pl. ix, 37.

Hinnites velatus Blake and Hudleston, 1877, all references in "The Corallian Rocks of England," *Q.J.G.S.*, xxxiii, pp. 260–405.

Hinnites tumidus Woodward, 1895, *Jurassic Rocks of Britain*, vol. v, pp. 121, 123.

Non *Hinnites tumidus* Hartmann-Zieten, 1830–3; Staesche, 1926 (which see for synonymy).

Hinnites bonjouri De Loriol, 1904, *Oxf. Sup. et Moy. du Jura Ledonien*, p. 231, pl. xxv, 1–2.

British Museum Coll. Nos. 23332, 23335, 23342 (all from the Malton Oolite), 47438 (Ayton, Yorks), 50550 (Bullingdon, Oxon, Shell-cum-Pebble Bed), 50999 (Weymouth); (all labelled *Hinnites abjectus*, Phillips); L. 6092 (Faringdon, matrix Pebble Bed).

Museum of Practical Geology Nos. 43112 (Malton Oolite); Hudleston Coll. Y. 1937 (Pickering, Yorks), Y. 1851 (Coral Rag, Watchfield, Berks, labelled *Hinnites corallensis* sp. nov. cf. *tombeckiana* De Lor.).

Diagnosis.—Shell large and variable in shape, covered with plain radial ribs, which are continuous over the large undifferentiated anterior auricle of the left valve, but not over the diminutive posterior auricle. The primary radial ribs number about 65 and vary in relative size. On the anterior and posterior regions of the shell they are separated by plain sulci; towards the centre the sulci are filled by up to three fine secondary ribs of similar form. The ribs do not bifurcate or increase in number with age, but become obscure, zigzag and irregular towards the margin in gerontic forms. No concentric ornamentation appears until old age, when coarse and fine irregular growth-lines begin to interrupt the radial ribbing.

The shell is thin and always appears to a certain extent malformed, being subject to a varying degree of knotting or puckering and local constriction.

Dimensions of a typical mature individual:—

Height. mm.	Length. %	Inflation (left valve). %	Apical Angle.	Number of ribs.
120	98	16	*c.* 90°	*c.* 65

Notes.—The above diagnosis and measurements are made from a perfect left valve from the Shell-cum-Pebble Bed of Headington, in Oxford University Museum. They may be considered as typical of the common British Corallian species, though the dimensions are very variable.

Of the figures of earlier continental authors that of Goldfuss' holotype agrees most closely with our species, both in shape and ornament, in the number of primary ribs (over fifty), the relative sizes of the auricles of the left valve, and the absence of radial ornament upon the posterior auricle of the left valve.

Besides the confusion in their generic or sub-generic name, which was for a long time confused with *Spondylus* and later *Hinnites*, and now has two rival claimants in the form of *Velopecten* and *Eopecten*, the various species have been widely confounded. Morris and Lycett's Great Oolite species figured under this name (loc. cit.) is obviously different, having too few primary ribs and a regular alternation of primaries and secondaries; further, the ribs have a beaded appearance not met with in the Corallian species. The *Eopecten velatus* of Paris and Richardson (*Q.J.G.S.*, lxxi, p. 532), which those authors state takes the place of *E. abjectus* Phil. in the Inferior Oolite of Dorset, embraces both Goldfuss' *Spondylus velatus*, *Pet. Ger.*, pl. cv, 4 (our species) and his *Pecten velatus*, ibid., pl. xc, 2, an entirely different species, which Staesche (1926) makes synonymous with *Pecten tumidus* Hart, of the Lower Lias. It is unlikely, therefore, that it is identical with our Corallian species.

Staesche, in his recent work *Die Pectiniden des Swäbischen Jura*, p. 122, has drawn greater confusion around this species by one of the customary synonymies, containing nineteen items. Of these only the references to figures can with safety be criticized ; of such it is impossible to accept the following :—

(i) *Hinnites spondyloides* Favre, *Zone à Am. acanthicus*, pl. ix, 7. The figure is too bad for identification, but it is stated on p. 74 that the species has only eighteen primary ribs, with a reticulate pattern in the sulci, formed by the intersection of fine concentric lines with radial secondaries of the same size.

(ii) *Hinnites astartinus* De Loriol, *Zone à Am. tenuilobatus*, pl. xxiii, 3, also has eighteen primary ribs with reticulate ornament in the sulci, and seems to be synonymous with (i).

(iii) *Hinnites aeberhardti* Rollier, *Fossiles nouveaux ou peu connus*, pl. xxix, 3–4, has too few ribs. Probably same as (i) and (ii).

(iv) *Hinnites argoviensis* Rollier, ibid., pl. xxix, 5–6, has an absolutely distinctive and peculiar " articulated " ornament, shown clearly in the enlargement, fig. 6.

(v) *Hinnites ernii* Rollier, ibid., pl. xxx, 1–4, has an equally peculiar reticulate pattern, shown clearly in fig. 4.

The differences between *Velopecten* and *Hinnites* need not here be repeated, since they have now been tabulated by several authors. I follow Staesche in adopting Philippi's *Velopecten* (1898) as merely an improvement of Quenstedt's *Velata* (1858), and therefore to be given priority over Douvillé's *Eopecten* (1897).

Horizon and Localities.—Common throughout the Corallian, from Lower Calc. Grit to Upper Calc. Grit.

V. List of Previously Recorded Species Omitted for Good Reasons from the Present Paper.

P. articulatus Schlotheim, 1820, *Petrefactenkunde*, p. 227. The holotype has at last been figured by Staesche (1926, *Die Pectiniden des Swäbischen Jura*, pl. i, 10–11), and turns out to belong to the *vagans* group ; it has therefore no resemblance to the forms of *Chlamys* which have been attributed to it by all authors but von Seebach, from Oppel onwards. Furthermore, the " Jurakalkstein der Gegend von Aarau ", in which it was found, is of Dogger (Lower Jurassic) age, and not Corallian, as has generally been assumed. The fossils usually attributed to *P. articulatus* in the Oxford district do not even agree with Goldfuss', Oppel's, Roemer's or Quenstedt's interpretation of Schlotheim's species, being assignable to *P.*

nattheimensis De Lor. This is discussed under the heading " Notes " under *Chlamys nattheimensis.*

A word of explanation is necessary concerning Morris and Lycett's interpretation of *P. articulatus,* which they state is found " In the Cornbrash of the Yorkshire coast and more frequently in the Calcareous Grit and Coralline Oolite of the same county " (*Great Oolite Mollusca,* Supplt., p. 32). The detail of the figure is too bad for identification ; in fact, no detail is inserted ; and the following would seem to point to the authors' notes having been confused before going to press.

(i) Morris and Lycett expressly state that their species is characterised by having about twenty-four ribs, but the specimen which they figure has at least thirty-one.

(ii) Although Goldfuss' interpretation of *P. articulatus* (*Pet. Ger.,* pl. xc, 10) is quoted at the head of their synonymy, Goldfuss' figure has at most twenty ribs, the very number which they point out is the distinguishing feature of Sowerby's *P. vimineus.*

P. demissus Phil. Recorded by Blake and Hudleston (1877) from various localities. Phillips' species is from the Lower Jurassic, the Corallian species found by Blake and Hudleston being *Entolium solidum* Roem. The differences are stated under *E. solidum* under the heading " Notes."

P. episcopalis De Lor. A left valve of *Chlamys nattheimensis* De Lor. stood exhibited under this name in Oxford University Museum. I have seen no specimens from England which could be attributed to this species. (See De Loriol, 1894, *Rauracien Inf. du Jura Bernois,* pl. vi, 2.)

P. similis Sow. (= *P. arcuatus* Sow.). Recorded in the lists of Whiteaves (1861) and Phillips (1871). This is probably a variety of *P. lens,* under which it is discussed.

P. subtextorius Goldfuss. Recorded by Blake and Hudleston from Marcham, Seend, and Westbrook, under the heading " Continental fossils recognized as British for the first time " (*Q.J.G.S.,* xxxiii, p. 400). As these authors made three records in one visit to the localities, while I have never seen even a fragment attributable to this species in oft-repeated collecting, or, indeed, in any collection of English Corallian fossils, it seems probable that their records refer to young specimens of *Chlamys splendens* Dollf., of which one was labelled *P. subtextorius* in Oxford University Museum. See *C. splendens,* Notes. I have not been able to find any specimen of *C. subtextoria* in the Hudleston or the Blake Collections.

P. vagans Sow. Sowerby's three syntypes (*Min. Conch.,* vol. vi, pl. DXLIII, 3–5) come from the Great Oolite and Cornbrash, but he adds (p. 82) " and in Oolite Limestone at Malton ". This has been the cause of *P. vagans* being often recorded from the Corallian, but every alleged case has so far proved on examination to be a left valve of *P. fibrosus.* The cause of more confusion is probably the typical *P. vagans* figured as *P. fibrosus* by Philippi in his *Beiträge* *zur Morphologie und Phylogenie der Lamellibranchier*, p. 98, fig. 15. The right valve is characterised by the twinned ribs.

P. vimineus Sow., 1829, *Min. Conch.*, vol. vi, p. 81, pl. DXLIII, 1–2. Holotype in the British Museum. Fortunately the holotype is in excellent condition and both valves are preserved. The respects in which it differs from *P. nattheimensis* De Lor., in mistake for which it has so often been recorded, may be summarised as follows :—

(i) The left valve bears twenty ribs and the right valve twenty-one ; in *P. nattheimensis* there are never less than twenty-three ribs and rarely less than twenty-four. The sulci are consequently wider than in *P. nattheimensis.*

(ii) On the left valve the concentric growth-lines pass straight across the sulci ; in *P. nattheimensis* they tongue down the sulci away from the umbo. (See Pl. XXXII, Fig. 2.)

(iii) The ornament of the right valve is entirely different. Whereas in *P. nattheimensis* the transverse or concentric ornament only differs in minor respects from that of the left valve, on the right valve of *P. vimineus* the transverse lamellae are not differentiated into major and minor, but are all of equal size, intermediate between the major and the minor, and are crowded together, covering both sulci and costae and obscuring them for a distance of 46 mm. from the umbo.

As already mentioned, the species is immediately distinguishable from the twenty-ribbed "*P. articulatus*" of Goldfuss, Oppel, Quenstedt, Roemer, etc. (non Schlotheim) by the much finer, non-spinous concentric ornament of the right valve.

In all the collections I have examined and in the field I have not seen a single *Pecten* from the English Corallian at all comparable with the holotype of *P. vimineus* Sow. Yet Sowerby wrote that it was "Plentiful in, and, indeed, characteristic of, the Oolitic Limestone of Malton". It is clear, therefore, that he confused either *C. nattheimensis* or *C. splendens*, or both, with his species. But Sowerby adds (p. 81) : "It also occurs at Ely, and in Gloucestershire." An examination of the matrix, a compact, buff-coloured limestone, quite different from the white oolite of Malton, leaves little doubt that the holotype is one of the Gloucestershire specimens and was obtained from the Inferior Oolite. I cannot detect any difference from the specimen figured by Paris and Richardson from the Inferior Oolite of Cleeve Hill, Cheltenham, as *Chlamys articulata* (auctt.), var. *sauzeana* nov. ("Some Inferior Oolite Pectinidae," 1915, *Q.J.G.S.*, lxxi, pl. xlv, 3*a*, 3*b*.)

"*Hinnites*" (*Velopecten*) *abjectus* Phillips. Recorded in Whiteaves' list (1861), but omitted by Phillips from his own list (1871). Phillips' species, which comes from the Great Oolite (*Geol. Yorks*, pl. ix, 37), differs from *Velopecten velatus* in having very irregular ribbing, in being less oblique, and in having more nearly equal-sized auricles on the left valve, the anterior auricle being smaller and the posterior larger.

"*Hinnites*" (*Velopecten*) *tumidus* Hartmann-Zieten. Recorded from Faringdon and Kingston Bagpuize, Berks, by H. B. Woodward, *Jurassic Rocks of Britain*, vol. v, pp. 121, 123; also in "The Geology of the Country Around Oxford," *Mem. Geol. Survey* (1908), p. 27. *Velopecten tumidus* is a Liassic species, figured by Goldfuss as *Pecten velatus*, *Petrefacta Germaniae*, pl. xc, 2 (non *Spondylus velatus*, ibid., pl. cv, 4 = *Velopecten velatus* Goldf.), which may have given rise to the confusion. See Staesche, 1926, *Die Pectiniden des Swäbischen Jura*, p. 117.

EXPLANATION OF PLATES XXXI–IV.

FIG.

PLATE XXXI.

1.—*Chlamys splendens* Dollfuss. Right valve, British Museum Coll. No. 23356, Malton Oolite, Yorks. The specimen is imbedded in hard oolite and has been somewhat scraped in freeing it from matrix.

2.—*Chlamys splendens* Dollf. Ornament of right valve. Coral Rag, Bullingdon, Oxford. Author's collection.

3.—*Chlamys splendens* Dollf. Left valve. Urchin Marls, Marcham, Berks. Author's collection.

4.—*Chlamys splendens* Dollf. Variety with about five more than the usual number of ribs. Right valve. Urchin Marls, Marcham, Berks. Author's collection.

PLATE XXXII.

1.—*Chlamys nattheimensis* De Loriol. Left valve. British Museum coll. No. L. 126, Malton, Yorks. Soft marl matrix.

2.—*Chlamys nattheimensis* De Lor. Ornament of left valve, showing V-shaped concentric lines in sulci. Coral Rag, Headington. Oxford University Museum collection.

3.—*Chlamys nattheimensis* De Lor. Right valve of same specimen as Fig. 1.

4.—*Chlamys* (*Aequipecten*) *qualicosta* Étallon. Right valve. British Museum coll. No. 34423. Malton Oolite, Yorks.

5.—*Chlamys* (*Aequipecten*) *qualicosta* Étall. Right valve; variety with concentric ornament as in left valve (compare ornament of left valve of *A. fibrosus* Sow.). British Museum No. L. 19972, J. F. Blake coll., Stourside, near Preston, Dorset.

PLATE XXXIII.

1.—*Chlamys* (*Camptonectes*) *giganteus* nov. Left valve, umbonal region. (Natural size.) Shell-cum-Pebble Bed, Headington, Oxford. Oxford University Museum collection. Syntype (iii).

2.—*Chlamys* cf. *blyensis* De Loriol. Left valve. Berkshire Oolites, Cowley. Oxford University Museum collection.

3.—*Chlamys* cf. *blyensis* De Loriol. Left valve. Ornament near junction of second and third zones. Same specimen as Fig. 2.

PLATE XXXIV.

1.—*Chlamys* (*Aequipecten*) *inaequicostatus* Phillips. Right valve with umbonal region missing. Shell-cum-Pebble Bed, Headington. Oxford University Museum collection.

2.—*Chlamys* (*Aequipecten*) *fibrosus* Sowerby. Typical left valve. Trigonia-Bed Limestones, Highworth, Wilts. Author's collection.

3.—*Chlamys* (*Aequipecten*) *fibrosus* Sow. Typical right valve (v. smooth). Lower Calcareous Grit, Pen Hill, near Swindon, Wilts. Author's collection.

4.—*Chlamys* (*Aequipecten*) *fibrosus* Sow. Local large race, Shell-cum-Pebble Bed, Headington. Left valve, showing incipient secondary ribs in the widened sulci, possibly anticipating *Pecten midas* Dollfuss of the Sandsfoot Grits. Oxford University Museum collection.

Fig.

5.—*Chlamys* (*Aequipecten*) *fibrosus* Sow. Large race, Shell-cum-Pebble Bed, Vicarage Quarry, Headington. Right valve. Author's collection.

6.—*Velopecten velatus* Goldfuss. Ornament of left valve, slightly enlarged (typical individual). Shell-cum-Pebble Bed, Windmill Quarry, Headington. Oxford University Museum collection.

Photographs by the author, Mr. A. D. Passmore and Mr. E. J. Manly.
All but micro-photographs natural size except where stated to the contrary.

The Post-Glacial Deposits of Airedale, Yorkshire.

By A. Raistrick, D.Sc., F.G.S.

During the last two years a series of deep excavations have been made in the floor of the Aire valley near Skipton (on the border of sheets 92 S.E. and 92 S.W. 1 inch to 1 mile, Geological Survey). These have brought to light a hitherto unsuspected deposit of laminated clays of great thickness, which are of considerable interest in interpreting the events of the Glacial retreat in this valley. A. Jowett and H. B. Muff in 1904 published their work on the glaciation of the Aire valley between Keighley and Bradford,[1] in the course of which they described three terminal moraines of the Aire glacier, at Tong Park, near Baildon, at Hirst Wood, about a mile and a half west of Shipley, and at Bingley; in the course of the paper they mention without comment the fact that above the Hirst Wood and Bingley moraines there is in each case an extensive flat of alluvial material, extending far up the valley. Although these have long been tacitly regarded as lake flats, the first confirmation was received in 1920 when the excavation of a deep trench in the flat half a mile west of the Hirst Wood moraine revealed a quantity of laminated clay underlying the undoubted river gravels. The excavation was only temporary, and unfortunately no measurements or deeper trials were obtained. Recently a trench above the Bingley moraine has been cut deep enough to show the laminated clay underlying the river gravels here as at Hirst Wood, and these two exposures have directed attention to the existence during late Glacial and post-Glacial times of a series of lakes held up by the terminal moraines left by the Airedale glacier. That such lakes existed has long been the opinion of most local geologists, but they have always been regarded as of brief duration, drainage being rapidly accomplished by breaching of the moraine barrier, or, in the Hirst Wood case, by super-deepening of the cut round the north end of the moraine, a cut probably initiated in late Glacial times. The material from the Skipton excavations indicates that these lakes were of far longer duration than previously suspected.

A few years ago it became necessary to repair the foundations of the bridge which carries the London, Midland and Scottish Railway, Colne branch line, over the river Aire, immediately west of Skipton station. The bridge was carried on six cylinders sunk on the banks and in the bed of the river. After the failure of the old foundations, steel caissons were erected around the cylinders, and the material excavated within them, with the object of strengthening or replacing the foundations by concrete. In this way the cylinders were sunk at various depths, up to nearly 60 feet below the river bed. The material excavated was examined on a series of visits over a period of nearly two years, and some of the sinkings have been examined at the same time. The river level at the bridge is approximately 306 ft. O.D. The sections measured in three of the sinkings are given below. These are arranged from west to east, the second being 44 ft. east of the first, and the third 57 ft. east again. No record was obtained of the material passed through in the original foundations, except that it was chiefly "sand and gravel".

---

[1] *Proc. Yorks. Geol. Soc.*, vol. xv, pt. 2, 1904, pp. 193–247.

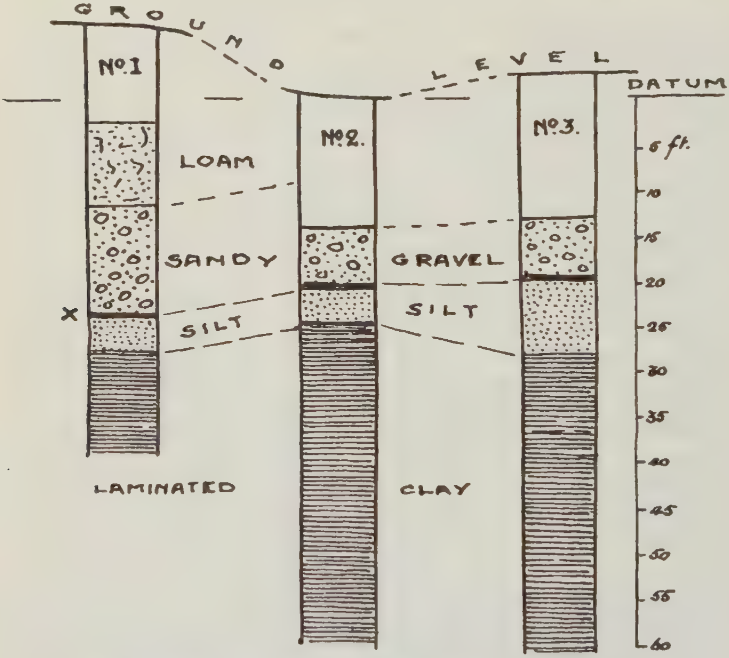


Fig. 1.—Section in valley floor, near Skipton, Airedale, Yorks. × marks position at which bones were found.

	No. 1		No. 2		No. 3	
	ft.	in.	ft.	in.	ft.	in.
Old foundations . .	2	9	14	0	13	6
Loamy soil . .	9	9	—		—	
Sandy gravel . .	12	0	6	0	6	6
Silt	4	0	4	0	8	0
Laminated clay . .	11	0	34	0	31	6

The measurements are commenced at the same datum and taken downwards, the great difference in depth of foundations of No. 1

and the others being due to the fact that this pier is built on the higher bank of the river, and so starts well above the datum, which is at river level. The most striking feature is the great thickness of laminated clay, the bottom of which has not been reached in any of the sinkings, though in one of them, a steel bar was driven many feet further without encountering any more marked resistance. In the cylinder here called No. 1 a group of bones was excavated at the base of the 12 ft. of gravel, resting on the surface of the silt. The bones include the scapulae, teeth, and odd vertebrae of *Equus caballus*, teeth and jaw of sheep and goat, and (?) tibia of ox. From the position of the bones in the cutting, which was here 6 feet diameter, it was clear that they had not been drifted into position, but in the case of the horse, certainly, were the result of decomposition of the carcass in that place. The bones were slightly embedded in the silt and the gravel passed evenly over them.

An excavation at the sewage works half a mile down the valley from the bridge has proved the laminated clay at the base of the gravel, at the same level below the datum. The clay is evidence of the permanence of the Skipton lake over a much longer time than previously imagined, and in fact suggests a fairly recent date for the gravels which would rapidly accumulate when the river began to wash over the boulder clay left by the ice. The pebbles of the gravel are identical in species with those of the boulder clay that fills the Aire gap to the west of Skipton. The Skipton lake was held up by a moraine at Cononley, and the flat in which the excavations occur stretches north-westward from Cononley for 4 miles and has an average breadth of half a mile. South of Cononley, and between Kildwick and Keighley, another similar flat occurs, but no deep cut has been made into it. From a shallow excavation, however, there is a brief report of mammalian bones from " the base of the river gravel ", and a group of bones in Ilkley Museum, from the gravels at the same point, include *Bos* sp. and one of the Deer family, represented only by part of the antlers.

The great depth of the rock floor of the valley indicated at Skipton is supported by borings at various points down the river course. At Keighley, a bore hole at Fleece Mills showed 70 feet of sand and gravel with clay, below the present valley level, before rock was reached, while a bore hole at Saltaire Mill, which started at 35 feet above the present river level, proved 150 feet of drift before reaching solid. Other bores have shown that the drift deposits in the floor of the valley average from 50 ft. to 100 ft. in depth. In all cases the line between the fine silts and laminated clays and the overlying coarse gravel is very sharp, and would suggest that the change from the quiet lake conditions to a rapid current capable of bringing such gravels was quickly accomplished. The cause of this sudden change in conditions, and the date of the change, is the subject of work still in progress, and seems to be linked up with changes over an area much wider than that of this note.

REVIEW.

Geologie von Europa, erster Band. By S. von Bubnoff. (Geologie der Erde.) pp. viii + 322, with 8 plates and 86 text-figures. Berlin: Borntraeger, 1926.

THIS, so far as the reviewer knows, is the second to appear of the parts of that contemplated great work *Geologie der Erde*, edited by Dr. Krenkel, of Leipzig. The general scope of the work was indicated in a review of the first volume of the *Geology of Africa*, and need not be again adverted to.

The present work falls clearly into two parts; the first 70 pages deal on the broadest lines with the general morphology and tectonic history of Europe as a whole: the rest deals in detail with Eastern Europe and the Baltic shield.

It is obviously a difficult matter to give a sketch of the geology of Europe in 70 pages, and the matter is necessarily much condensed. A good deal of it, as a matter of fact, forms very tough reading, although the style is clear and lucid. The treatment naturally follows closely the lines of the author's earlier work, *Die Gliederung der Erdrinde*, in which much stress was laid on the importance of the shelf as a tectonic element, in contrast to the stable continental blocks, the geosynclinals, and the oceanic deeps. Much of Central Europe comes under the designation of shelf, and some of the terminology is not as yet familiar to most English readers. (In parenthesis it may be remarked that the author's use of the word England is a little uncertain. Sometimes, apparently, it includes Wales and Scotland, and even perhaps Ireland; sometimes it is what we in this country understand by the word.) The historical (stratigraphical) section on Europe as a whole is accompanied by numerous maps, which owing to the very small scale are not always as clear as they might be, and in some cases the stippling of the legend is not quite the same as that of the map, so that it is difficult to make out what the different areas really represent. This, of course, is always a difficulty in small black-and-white maps. The map on p. 57, showing the structural elements of Europe, is extremely difficult to make out. Most buyers of such a book would cheerfully pay a mark or two more for a really clear map on a larger scale showing conclusions of so much importance, the result of such a vast amount of synthetic work; it is evident that the author has obtained a very complete grasp of the vast literature of the subject, and, above all, his intimate acquaintance with Russian and other East European geology is of the utmost value in his treatment of it. In this section we have found few errors, but surely on page 40 the author cannot really mean that the Aptian is above the Albian, as shown in his table. One further criticism may be permitted: it is distressing to English readers still to find the "Lower Silurian" in full glory and a reference to the "intense volcanic activity of the Silurian" reads oddly in this country; it is only fair to say, however, that the "Ordovizium" does occur in tables. The author seems to incline to the opinion that the schistose rocks of the Scottish Highlands include Lower Palaeozoic strata. In the palaeographic map on page 15 the whole area south of the Great Glen is shown as "metamorphic series with Lower Silurian", while the northern Highlands appear to be "Icelandic facies" like the extreme north of Norway. It is of interest to note that in the general tectonic map the whole of the English Midlands and East Anglia appear as a Mesozoic folded chain, although in other sections some doubt is expressed as to the validity of the Cimmerian phase of Stille and other authors.

We do not propose to offer here any criticisms, or even a summary, of the major part of the book, on the geology of the east of Europe; no one but a competent Russian scholar has any right to express an opinion on this subject; western geologists can but read and assimilate the extremely valuable summary here available. This is illustrated by a number of maps on a reasonably large scale, and six of the plates also refer to it, including some fine pictures of Russian landscapes; these comprise typical views in the Urals and on the great rivers of that country, which are of much interest from the physiographical point of view; the type of river-bank here shown differs greatly from anything that is commonly found in this country: the Trent at Gainsborough is the nearest parallel that occurs to the writer.

The third section of the book is occupied by a discussion of the structure of the Baltic Shield, a region of great interest and to some extent known to British geologists, through the illuminating work of Norwegian, Swedish, and Finnish authors. Nevertheless, a good deal of doubt seems to prevail as to the details of the Pre-Cambrian history, and the relations of the different rock-types there seen. At any rate, it is clear that this history is long and complex. A small but very clear map of the main elements shows on the whole prevalent N.–S. structure-lines, with many local variations. An extraordinary picture, after Asklund, gives a vivid idea of the dominance of faulting, mostly pre-Jotnian, in the shield. Emphasis is laid on the fact that this was not always a block, but acted as a shelf-area up to the end of the Silurian. After this, the next phase of sedimentation was in the Quaternary, and here the subject may well be left.

REPORTS AND PROCEEDINGS.

Glasgow Geological Society.

14th October, 1926.

" A Preliminary Account of the Post-Dalradian Geology of Kintyre." By W. J. McCallien, B.Sc.

The area described is part of the district south of a north-west—south-east line through Campbeltown, and includes the islands of Davarr and Sanda. The western and south-western portion of the area is composed of pre-Cambrian metamorphic rocks, and faulted into the Old Red Sandstone south of Campbeltown Loch is a triangular mass of similar rocks. The Old Red Sandstone occupies the greater part of the remainder. Its basal bed is a breccia of the underlying schists. The conglomerates of the Lower Old Red comprise boulders of igneous rocks and quartzite ; those of the upper contain vein quartz and Highland rocks. Cornstones are characteristic of the Upper, and agglomerates occur in the Lower.

Carboniferous occurs at Southend and Machrihanish in basins in the Old Red Sandstone, the Lower Old Red Sandstone rising between them in an anticline. The Calciferous Sandstone lavas of these two areas consist of the usual basalts with soda-trachytes and trachyandesites. Limestones, shales, sandstones, and coals of Carboniferous Limestone age occur in two detached areas in the Machrihanish basin.

Intrusives fall into three groups. (1) Three volcanic necks piercing the Lower Old Red Sandstone conglomerates at Southend ; (2) intrusions of orthophyre, keratophyre, and trachyandesite of Lower Carboniferous age ; (3) Kainozoic intrusions of olivine-dolerite, crinanite, and monchiquite. There are three groups of faults oriented east—west, north—south and north-west—south-east. The age of the east—west and north—south faults is determined by their association with similarly oriented acid intrusions of Carboniferous age. The north-west—south-east faults are Kainozoic.

The Old Red Sandstone has been laid down on an irregular platform against the north-eastern slopes of the Mull (of Kintyre) mountains. There is no fault with the magnitude generally attributed to the Highland Boundary Fault. The presence of such a fault is very difficult to determine in this part of south-west Scotland. In Arran there is only a minor fault connected with the intrusion of the Kainozoic granites. At Toward the Old Red Sandstone breccia and cornstone are not faulted against the schists, but occur in the position in which they were laid down ; there is no disturbance or crush-breccia, and the beds are quite horizontal. There is a breccia near the junction, but there is no Old Red in it. There appears to have been a pre-Old Red Sandstone fault scarp against which the Old Red Sandstone was laid down.

INDEX.

AFRICA, South, Geological Map of, E. J. Dunn, 289.
African Geology, E. Krenkel, 93.
Age of the Duruma Sandstone, East Africa, J. W. Gregory, 83.
Alexander, A. S., Tramps Across Watersheds, 180.
Alexander, Miss M. F., The Problem of the Quartz-dolerites, 187.
Alpine Zone, Recent Volcanic Eruptions in Central, C. G. S. Sandberg, 469.
American Soil Survey Work, J. O. Veatch, 45.
Ammonites, Blake Collection from Kachh, India, L. F. Spath, 527.
— from the Upper Kimmeridge Clay, E. Neaverson, 139.
— New, from the English Chalk, L. F. Spath, 77.
— Type, S. S. Buckman, 233.
Anal Plates of *Eupachycrinus calyx* and *Zeacrinus konincki*, J. Wright, 145.
Apatite in Sedimentary Rocks, Wm. Mackie, 238.
Arkell, W. J., Corallian Lamellibranchs, 193, 534.
Arthropod Remains from the Rhynie Chert, S. Hirst and S. Maulik, 69.

BACKLUND, H. G., The Andes of S. Mendoza, 410.
Bailey, E. B., Domes in Scotland and South Africa, 481.
— — Plant-Migration across the Millstone Grit, 49.
— — Subterranean Penetration by a Desert Climate, 276.
Bala-Silurian Succession in the Llangranog District, E. M. Lind Hendriks, 121.
Bardon Hill, Petrology and Structure of the Charnian Rocks of, F. Jones, 241.
Basic Micas, A. F. Hallimond, 143.
Bath Springs, Note on the Geology of the, R. H. Rastall, 98.
Beadnell, H. J. L., Columnar Structure of the Nubian Sandstone, 271.
Berthierite, the Nature of, F. L. Stillwell, 381.
Berwickshire and Roxburghshire, W. S. Crockett, 379.
Binny Crag, W. Lothian, Intrusion of, J. Lunn, 186.
Birmingham, Geology of the Country Around, T. Eastwood, T. H. Whitehead, and T. Robertson, 235.
Black Forest, Geological and Petrographical Studies, S. K. Ray, 432.
Borth, Cardiganshire, Curious Marks on Rock Surface near, J. Challinor and K. E. Williams, 341.
Boulders, Scandinavian, Distribution in Britain, J. Phemister, 433.
Brammall, A., Primary Gold and Silver in Dartmoor Granite, 143.
Brighton, A. G., Eocene Echinoids, N.W. Peru, 359.
— — New Miocene Echinoid from Peru, 61.
Buckley, H. E., Anomalous Optical Properties of Isomorphous Double Tartrates, 382.
Buckman, S. S., Type Ammonites, 233.
Bushveld Igneous Complex (Transvaal), C. G. S. Sandberg, 210.
Busk, H. G., Shimbar Landslip Dam, Persia, 355.

CADELL, H. M., Rocks of West Lothian, 179.
Caenophyllum gen. nov., 85.
— a New Genus of Carboniferous Coral, A. E. Clark, 85.
— *varians* sp. nov., 85.
Campbell, R., On Chlorophaeite, 46.
Camptonectes giganteus sp. nov., 541.
Canada, Geological Survey, Index to Palaeontology, F. Nicolas, 333.
Carboniferous Coral, *Caenophyllum*, a New Genus, A. E. Clark, 85.
Carboniferous Echinoid, New, from Northumberland, R. T. Jackson, 529.
Cardiganshire, South, Bala-Silurian Succession in, E. M. Lind Hendriks, 121.
Carlisle, Longtown and Silloth District, Geology of, E. E. L. Dixon, J. Maden, F. M. Trotter, S. E. Hollingworth, and L. H. Tonks, 377.
Carstone and Associated Beds, Petrography of, H. C. Versey, 287.

Cenomanian, New Ammonites, L. F. Spath, 77.
Chalk Sections in N.E. Surrey, A. G. Davis, 95.
Challinor, J., Curious Marks on a Rock Surface, 341.
Charlestown, Fife, Teschenite Sill of, F. Walker, 343.
Charlesworth, J. Kaye, Evishanoran "Esker", Tyrone, 223.
Chhibber, H. L., Oolite, Pisolite, and Torolite, 96.
Chloritic Minerals Associated with the Basaltic Carboniferous Rocks of Derbyshire, S. I. Tomkeieff, 383.
Chlorophacite, R. Campbell and James Lunn, 46.
Clark, A. E., *Caenophyllum*, a New Genus of Carboniferous Coral, 85.
— K., A Pioneer of Prehistory, 41.
Climate and Coloration in the Soudan, G. W. Grabham, 280.
Coal Measures of Yorkshire, Grindstones from, H. P. Lewis and W. J. Rees, 13.
Coalfields of Ayrshire, Economic Geology of, J. E. Richey, G. V. Wilson, and E. M. Anderson, 331.
Codazzi, R. Ll., Descriptive Catalogue of the Minerals of Muso, 38.
Coleman, A. P., Magmatic Origin of the Sudbury Nickel Ores, 108.
Coloured Strata, Glamorgan and Monmouth Coalfields, A. Howell and A. H. Cox, 142, 430.
Columnar Structure of the Nubian Sandstone, H. J. L. Beadnell, 271.
Compression, Regions of, J. W. Evans, 237.
Continents and Oceans, Origin of, A. Wegener, 181.
Corallian Lamellibranch Fauna, W. J. Arkell, 193, 534.
Corals, Explanations of the Bilateral Symmetry of Rugose, N. N. Yakowlev, 264.
Cornes, H.W., Recent Sections in the Glacial Deposits of the Finchley Plateau, 95.
Cornish Geology, Handbook of, E. H. Davison, 430.
Coupland, G., Superficial Deposits near Sunderland,
Cox, A. H., Coloured Strata, Glamorgan and Monmouth Coalfields, 142 and 430.
— — Lower Coal Measures, Glamorgan and Monmouth, 14.
Coysh, A. W., Shell-bearing Tufa near Lydney, 354.
Crania renamed *Heterocrania* (see p. 70), 288.
Crania rhyniensis gen. and sp. nov., 70.
Cretaceous Plant-bearing Rocks of Western Greenland, A. C. Seward, 236.
Crockett, W. S., Berwickshire and Roxburghshire, 379.
Crouch Valley, Essex, Age of the, J. W. Gregory, 273.
Crustaceans (*Callianassa*) from Barbados, T. H. Withers, 104.

DAVIES, Morley, Oolitic Rhaxella Chert from Essex, 272.
Davis, A. G., Chalk Sections in N.E. Surrey, 95.
— R., Lower Coal Measures, Glamorgan and Monmouth, 142.
Davison, E. H., Handbook of Cornish Geology, 430.
Day, T. C., Bombs of Nepheline-Basanite in the Partan Crag Vent, E. Lothian, 187.
— — Chemical Analyses of Quartz-Dolerites from N. Queensferry, 186.
— — Volcanic Vents on the Shore east of N. Berwick, 45.
Decapod Crustaceans (*Callianassa*) from Barbados, T. H. Withers, 104.
Delta Formation in the English Lakes, T. Hay, 292.
de Martonne, Emm., Physical Geography, 178.
Desert Climate, Subterranean Penetration by a, E. B. Bailey, 276.
Diener, C., Typical Triassic Fossils, 233.
Dixey, F., Physiography of the Shire Valley, 186.
Dixon, E. E. L., Geology of Carlisle, Longtown, and Silloth Districts, 377.
Dolerite Dyke in the Rubislaw Quarry, Aberdeen, F. M'Leod Glennie, 187.
Domes in Scotland and S. Africa, E. B. Bailey, 481.
Dunn, E. J., Geological Map of South Africa, 289.
Duruma Sandstone, East Africa, Age of, J. W. Gergory, 83.

EARDLEY-WILMOT, V. L., Molybdenum : Metallurgy and Uses, 232.
Earth's Crust in Finland, Average Composition of, J. J. Sederholm, 91.
Earth History, An Introduction to, H. W. Shimer, 182.
— Surface-History of the, J. Joly, 231.
Earth's Thermal History, H. Jeffreys, 516.
East Indies, Geology of, J. B. Scrivenor, 240.
Eastwood, T., Geology of the Country around Birmigham, 235.
Echinoid, New Carboniferous, from Northumberland, R. T. Jackson, 529.
Echinoid from N.W. Peru, A New Miocene, A. G. Brighton, 61.
— Genus *Oligopygus* De Loriol, H. L. Hawkins, 371.
Echinoids, Eocene, N. W. Peru, A. G. Brighton, 359.
Echinolampas atascaderensis sp. nov., 370.
Edinburgh Geological Society, 45, 95, 96, 186.
Encope peruviana sp. nov., 61.
Eocene Echinoids, N.W. Peru, A. G. Brighton, 359.
— Foraminifera of Western India, W. L. F. Nuttall, 495.
"Esker", Evishanoran, J. W. Gregory, 336.
— — Tyrone, J. Kaye Charlesworth, 223.
Eupachycrinus calyx and *Zeacrinus konincki*, J. Wright, 145.
European Geology, Vol. I, S. von Bubnoff, 558.
Evans, J. W., Regions of Compression, 237.
Evishanoran "Esker", Tyrone, J. Kaye Charlesworth, 223.
Evolution, J. Graham Kerr, 226.

FARQUHARSON, R. A., Geology and Mineral Resources of British Somaliland, 185.
Felixburg Goldfield, Geology of, A. M. Macgregor, 229.
Fleet, W. F., Petrological Notes on the Old Red Sandstone of the W. Midlands, 505.
Foothills from Masham to Wetherby, Drainage of, W. H. Young, 287.
Foraminifera, Upper Ranicot Series of Sind, India, W. L. F. Nuttall, 112.

GARWOOD, E. J., Problems in River Development, 46.
Geological Society of London :—
  Annual General Meeting and Election of Officers and Council, 97.
  Award of Medals, 97.
  Presidential Address, 237.
Geological Survey Memoirs, 377, 480.
— — Scotland Memoirs, 277, 331.
Geologists' Association, 43, 94, 286.
— — Annual General Meeting and Election of Officers for 1926, 97.
Geology, Introduction to, J. Leuba, 177.
Gibson, W., Geology of the Country around Stoke-upon-Trent, 480.
Glacial Deposits of the Finchley Plateau, Recent Sections in the, H. W. Cornes, 95.
— Features in a New Exposure at Finchley, N. L. Silvester 95.
Glasgow District, Geology of, 2nd Ed., Revised by M. Macgregor, C. H. Dinham, E. B. Bailey and E M. Anderson, 227.
— Geological Society, 238, 284, 560.
Glennie, F. M'Leod, Dolerite Dyke in the Rubislaw Quarry, Aberdeen, 187.
Gold Coast, B.W.A., Mineral and Water Power Resources, A. E. Kitson, 92.
— and Silver, Primary, in the Dartmoor Granite, A. Brammall, 143.
Goniometer, an X-ray, G. Greenwood, 143.
Gossling, F., Outliers of Lenham Beds, Sanderstead, Surrey, 94.
Gotlandian, the Term and its Implications, E. Greenly, 176.
Grabham, G. W., Red Coloration in the Soudan, 280.
Gravels of Little Hayes, Essex, J. W. Gregory, 273
Green Island and Amherst (Burma), Igneous Complex of, L. D. Stamp, 399.
Greenly, E., Orders of Validity in Geological Theory, 176.
— — The Term Gotlandian and its Implications, 176.
Greenwood, G., Construction and Use of an X-ray Goniometer, 143.
Gregory, J. W., Age of the Duruma Sandstone, E. Africa, 83.
— — Gravels of Little Hayes, 273.
— — The Evishanoran "Esker", 336.
— — Sudbury Nickel Ores, 190.

Grindstones from the Coal Measures of Yorkshire, H. P. Lewis and W. J. Rees, 13.
Gunther, R. T., Early Medical and Biological Science, 479.
Gutenberg, B., Structure of the Earth, 37.

HALLIMOND, A. F., Basic Micas, 143.
Harker, A., Sudbury Laccolite, 192.
Harmer, F. W., the late—Pluvial Period of Central and Southern Italy, 27.
Harris, J. W., Intrusive Igneous Rocks, Dundee District, 95.
Hatch, F. H., Petrology of the Igneous Rocks, 282.
Hawkins, H. L., Echinoid Genus *Oligopygus* De Loriol, 371.
Hay, T., Delta Formation in the English Lakes, 292.
Hendriks, E. M. Lind, Bala-Silurian Succession in S. Cardiganshire, 121.
Heterocrania substituted for *Crania* (see p. 70), 288.
Hevesy, G., Manual of Radioactivity, 527.
Hirst, S., Arthropod Remains from The Rhynie Chert, 69.
Holmes, A., Contributions to the Theory of Magmatic Cycles, 306.
— — Problem of Geological Time, 525.
— — Theory of Magmatic Cycles, 384.
— — Vulcanism and Metallogeny, 335.
Holtedahl, O., Moraines near Oslo Fjord, 380.
Howell, A., Coloured Strata Glamorgan and Monmouth Coalfields, 142, 430.
Hutchinson, A., elected Professor of Mineralogy, University of Cambridge, 337.
Hutchinson, A. G., A Lava at the Base of the Downtonian, Stonehaven, 95.

ICE-SHEET, Retreat of the last from Eastern Canada, E. Antevs, 48.
Igneous Action and Earth Movements, G. W. Tyrrell, 284.
— Complex, Bushveld (Transvaal), C. G. S. Sandberg, 210.
— — of Green Island and Amherst (Burma), L. D. Stamp, 399.
Igneous Petrography, Systematic K. H. Scheumann, 140.
— Rocks, Petrology of, F. H. Hatch and A. K. Wells, 282.
International Geological Congress, Belgium, 40.
Intra-coal Measure Movements, R. Davies, 142.
Intrusive Igneous Rocks, Dundee District, J. W. Harris, 95.
Invertebrate Palaeontology, H. Woods, 180.
Isomorphous Double Tartrates, Anomalous Optical Properties, H. E. Buckley, 382.
Italy, Pluvial Period of Central and Southern, the late F. W. Harmer, 27.

JACKSON, R. T., New Carboniferous Echinoid from Northumberland, 529.
Japanese Earthquake of 1923, 230.
Jeffreys, H., Earth's Thermal History, 516.
Johnson, D., New England-Acadian Shoreline, 333.
Johnstone, J., Study of the Oceans, 330.
Joly, J., Surface-History of the Earth, 231.
Jones, F., Petrology and Structure of the Charnian Rocks of Bardon Hill, 241.
Jones, W. R., Tinfields of the World, 330.

KAILPOT, Ullswater, J. E. Marr, 338.
Kendall, J. D., Formation of Rock Basins, 165.
Kerr, J. Graham, Evolution, 226.
Kitchin, F. L., So-called Malone Jurassic Formation in Texas, 454.
Kitson, A. E., Mineral and Water Power Resources of the Gold Coast, B.W.A., 92.
Krenkel, E., African Geology, 93.

LAKE HURON, Geology of the N. Shore, W. H. Collins, 48.
Lakes, English, Delta Formation in the, T. Hay, 292.
Landslip Dam, Shimbar, Persia, H. G. Busk, 355.
Lang, W. D., Submerged Forest at the Mouth of the River Char, 43.
Lava at the Base of the Downtonian, Stonehaven, A. G. Hutchinson, 95.

Lenham Beds, Sanderstead, Surrey, F. Gossling and S. W. Wooldridge, 94.

Lepidesthes howsei sp. nov., 529.

Leuba, J., Introduction to Geology, 177.

Lewis, H. P., Grindstones from the Coal Measures of Yorkshire, 13.

Limidae, from Oxford, Berks, and Wilts, W. J. Arkell, 193.

London Basin, Structural Evolution of, S. W. Wooldridge, 44.

Lower Coal Measures, Glamorganshire and Monmouth, R. Davis and A. H. Cox, 142.

Lunn, J., Intrusion of Binny Crag, W. Lothian, 186.

— — On Chlorophaeite, 46.

MACCARTHY, G. R., Radioactivity of the Floor of the Ocean, 301.

Macgregor, A. M., Geology of the Felixburg Goldfield, 229.

— M., Geology of the Glasgow District, 227.

Mackie, Wm., Apatite in Sedimentary Rocks, 238.

Macmillan, W. E. F., Yeovilian Ammonites, Yorkshire Moors, 287.

Magmatic Activity in the Andes of S. Mendoza, H. G. Backlund, 410.

— Cycles, Contributions to the Theory of, A. Holmes, 306, 384.

— Origin of the Sudbury Nickel Ores, A. P. Coleman, 108.

McCallien, W. J., Post-Dalradian Geology of Kintyre, 560.

Malone Jurassic (So-called) Formation in Texas, F. L. Kitchin, 454.

Marr, J. E., Kailpot, Ullswater, 338.

— — Pleistocene Deposits of the Great Ouse Basin, 239.

Map of South Africa, Geological, E. J. Dunn, 289.

Maufe, H. B., Geology of Southern Rhodesia, 288.

Maulik, S., Arthropod Remains from the Rhynie Chert, 69.

Medical and Biological Science, Early, R. T. Gunther, 479.

Metalliferous deposits and tectonic elements, Spain, F. Schumacher, 479.

Meteorites, Brit. Mus., Nat. Hist., Guide to the Collection of, 232.

— South African, G. T. Prior, 382.

Mica-Lamprophyres of Wigtownshire, H. H. Read, 422.

Miller, W. J., An Introduction to Physical Geography, 42.

Millstone Grit near Haverfordwest, A. E. Trueman, 47.

— — Plant Migration across the, E. B. Bailey, 49.

Mineralogical Society, 142, 381.

— Transformations in Crystalline Schists, C. E. Tilley, 142.

Minerals of the Mines of Muso, Catalogue of, R. Ll. Codazzi, 38.

Mining, Geology Applied to, J. E. Spurr, 528.

Miocene Echinoid, New, from N.W. Peru, A. G. Brighton, 61.

Molybdenum : Metallurgy and Uses, V. L. Eardley-Wilmot, 232.

Mook, C. C., Thrust-Faulting in Western Newfoundland, 348.

Moraine near Oslo Fjord, O. Holtedahl, 380.

Moranocladus Oldhami (Zeill) substituted for *Araucarites Oldhami* (Palaeontologia Indica), 1920, 288.

Mountain Folding in the Andes of S. Mendoza, H. G. Backlund, 410.

NEAVERSON, E., Ammonites from the Upper Kimmeridge Clay, 139.

Nepheline-Basanite Bombs in the Partan Crag Vent, E. Lothian, T. C. Day, 187.

Newfoundland, Thrust-Faulting in Western, C. C. Mook, 348.

Newton, R. B., Obituary Notice of, 144.

Nickel Ores of Sudbury, the Magmatic Origin of, A. P. Coleman, 108.

Nicolas, F., Index to Palaeontology, Geol. Surv. Canada, 333.

Nigeria, Geological Survey of (Brown Coal), R. C. Wilson, 42.

— Southern, Youngest Beds of, J. Parkinson, 350.

— Youngest Beds of, J. Parkinson, 528

North, F. J., Slates of Wales, 40.

Nubian Sandstone, Columnar Structure of the, H. J. L. Beadnell, 271.

Nuttall, W. L. F., Eocene Foraminifera, of Western India, 495.

— — Larger Foraminifera of the Upper Ranikot Series, India, 112.

OBITUARIES :—
R. B. Newton, I.S.O., F.G.S., 144.
Benjamin Neeve Peach, 187.

Obrutschew, W. A., Geology of Siberia, 184.
Ocean Floor, Radio-activity of the, G. R. MacCarthy, 301.
Oceans, Study of the, J. Johnstone, 330.
Old Red Sandstone of Gower, Upper and Lower, Daisy M. Williams, 219.
— — — of the West Midlands, W. F. Fleet, 505.
Oligopygus De Loriol, Echinoid Genus, H. L. Hawkins, 371.
— *ovumserpentis* var. *baldryi* nov., 361.
Oolite, Pisolite, and Torolite, H. L. Chhibber and L. Dudley Stamp, 96.
Oolitic Rhaxella Chert from Little Hayes, A. M. Davies, 272.
Osteology of the Reptiles, the late S. W. Williston, 227.

PALAEONTOLOGY, Text-book of Vol. III, Mammalia, Karl A. von Zittel, 89.
Palagonite Formation of Iceland, M. A. Peacock, 385.
Parkinson, J., Central Range of Trinidad, 383.
— — Youngest Beds of S. Nigeria, 350, 528.
Peach, B. N., Obituary of, 187.
Peacock, M. A., Palagonite Formation of Iceland, 385.
Pectinidæ, Corallian, W. J. Arkell, 534.
Permo-Triassic Rocks, Correlation of the British, R. L. Sherlock, 94.
Peru, Geological Society of, 233.
Petroleum in Uganda, E. J. Wayland, 431.
Petrological Notes on the Old Red Sandstone of the W. Midlands, W. F. Fleet, 505.
Petrology and Structure, Charnian Rocks, of Bardon Hill, F. Jones, 241.
Phemister, J., Distribution of Scandinavian Boulders in Britain, 433.
Phillips, F. Coles, Riebeckite-bearing Rock from the Shetlands, 72.
Physical Geography, Emm. de Martonne, 178.
— — Introduction to, W. J. Miller, 42.
Pilandsberg, an African Ring Complex, S. J. Shand, 96.
Plagiostoma highworthensis sp. nov., 203.
— *mutabilis* sp. nov., 201.
— *zonata* sp. nov., 199.
Plant Migration across the Millstone Grit, E. B. Bailey, 49.
Pleistocene Deposits of the Great Ouse Basin, J. E. Marr, 239.
Pluvial Period of Central and Southern Italy, the late F. W. Harmer, 27.
Plymen, G. H., Preliminary Survey of the Geology of Sark, 255.
Post-Dalradian Geology of Kintyre, W. J. McCallien, 560.
Post - Glacial Deposits, Airedale, Yorks., A. Raistrick, 255.
Pothole at Ullswater, J. E. Marr, 338.
Pre-glacial gravel from Little Hayes, Essex, A. M. Davies, 272.
Prehistory, a Pioneer of, K. Clark, 41.
Prior, G. T., South African Meteorites, 382.
Problem of Geological Time, A. Holmes, 525.

QUARTZ-DOLERITES, from N. Queensferry, Chemical Analyses, T. C. Day, 186.
— — the Problem of the, F. Walker and Miss M. F. Alexander, 187.
Quaternary Sequence in E. Durham, G. Coupland and D. Woolacott, 1.

RADIOACTIVITY and the Floor of the Oceans, G. R. MacCarthy, 301.
— — Manual of, G. Hevesy, F. Paneth, and R. W. Lawson, 527.
Raistrick, A., Post-Glacial Deposits, Airedale, Yorks., 255.
Rastall, R. H., Note on the Geology of the Bath Springs, 98.
Ray, S. K., Geological and Petrographical Studies in the Black Forest, 432.
Read, H. H., Mica-Lamprophyres of Wigtownshire, 422.
Red Coloration in the Soudan, G. W. Grabham, 280.
Rees, W. J., Grindstones from the Coal Measures of Yorkshire, 13.
Rhodesia, Geology of Southern, H. B. Maufe, 288.
Rhynchopygus peruvianus sp. nov., 366.
Rhynie Chert, Arthropod Remains from the, S. Hirst and S. Maulik, 69.

Rhyniella praecursor gen. and sp. n., 71.
Richey, J. E., Economic Geology of Ayrshire Coalfields, 331.
Riebeckite-bearing Rock from the Shetlands, F. Coles Phillips, 72.
River Development, Problems in, E. J. Garwood, 46.
Rock Basins, Formation of, J. D. Kendall, 165.
Rock Surface, Curious Marks on a, J. Challinor and K. E. Williams, 341.
Rocks of West Lothian, H. M. Cadell, 179.
Royal Society, 236.
Rugose Corals, Explanations of the Bilateral Symmetry of, N. N. Yakowlev, 264.

SAND from the Ure and the Ouse above York, S. Melmore, 269.
Sandberg, C. G. S., Bushveld Igneous Complex, 210.
— — Recent Volcanic Eruptions in Central Alpine Zones, 469.
Sark, Preliminary Survey of the Geology of, G. H. Plymen, 255.
Scandinavian Boulders in Britain, Distribution of, J. Phemister, 433.
Scheumann, K. H., Systematic Igneous Petrography, 140.
Schumacher, F., Metalliferous Deposits and Tectonic Elements of Spain, 479.
Scrivenor, J. B., Geology of the East Indies, 240.
Sederholm, J. J., Average Composition of the Earth's Crust in Finland, 91.
Sedimentation, Researches in, 1924, W. H. Twenhofel, 39.
Seward, A. C., Cretaceous Plant-bearing Rocks of Western Greenland, 236.
Shand, S. J., Pilandsberg, an African Ring Complex, 96.
Shap Granite, Petrology of, D. R. Grantham, 286.
Shell-bearing Tufa near Lydney, Gloucestershire, A. W. Coysh, 354.
Sherlock, R. L., Correlation of the British Permo-Triassic Rocks, 94.
Shetlands, Riebeckite-bearing Rock from the, F. Coles Phillips, 72.
Shimbar Landslip Dam, Persia, H. G. Busk, 355.
Shimer, H. W., An Introduction to Earth History, 182.
Shire Valley, Physiography of the, F. Dixey, 186.
Shoreline, New England-Acadian, D. Johnson, 333.
Shoshone Valley, Yellowstone Park, U.S.A., G. W. Young, 286.
Siberia, Geology of, W. A. Obrutschew, 184.
Silvester, N. L., Glacial Features in a New Exposure at N. Finchley, 95.
Slates of Wales, F. J. North, 40.
Smith, William, Tablet unveiled at Bath to memory of, 337.
Somaliland, British, Geology and Mineral Resources of, R. A. Farquharson, 185.
Spath, L. F., Blake Collection of Ammonites from Kachh, India, 527.
— — New Ammonites from the English Chalk, 77.
Spencer, L. J., Sperrylite Crystal from the Transvaal, 382.
Sperrylite Crystal from the Transvaal, L. J. Spencer, 382.
Springs at Bath, Note on the Geology of, R. H. Rastall, 98.
Spurr, J. E., Geology Applied to Mining, 528.
Stamp, L. Dudley, Geology of Green Island and Amherst, 399.
— — Oolite, Pisolite, and Torolite, 96.
Stillwell, F. L., The Nature of Berthierite, 381.
Stoke-upon-Trent, Geology of the Country Around, W. Gibson, C. B. Wedd, and A. Scott, 480.
Strahan, Sir A., Geology of the Thames Valley, near Goring, 43.
Structure of the Earth, B. Gutenberg, 37.
Submerged Forest at the Mouth of the River Char, W. D. Lang, 43.
Subterranean Penetration by a Desert Climate, E. B. Bailey, 276.
Sudbury Laccolite, A. Harker, 192.
Sudbury Nickel Ores, J. W. Gregory, 190.
Sunderland, Superficial Deposits near, G. Coupland and D. Woolacott, 1.

TESCHENITE Sill of Charlestown, Fife, F. Walker, 343.
Texas, The So-called Malone Jurassic Formation in, F. L. Kitchin, 454.
Thames Valley, near Goring, Geology of, Sir A. Strahan, 43.

Thermal History of the Earth, H. Jeffreys, 516.
Thrust-Faulting in Western Newfoundland, C. C. Mook, 348.
Tilley, C. E., Mineralogical Transformations in Crystalline Schists, 142.
Tinfields of the World, W. R. Jones, 330.
Tomkeieff, S. I., Chloritic Minerals, 381.
Triassic Fossil, Typical, C. Diener, 233.
Trinidad, Central Range of, J. Parkinson, 383.
Trueman, A. E., Millstone Grit near Haverfordwest, 47.
Tufa, shell-bearing near Lydney, Gloucestershire, A. W. Coysh, 354.
Twenhofel, W. H., Researches in Sedimentation in 1924, 39.
Tyrrell, G. W., Igneous Action and Earth Movements, 284.

UPPER Ranikot Series, Sind, India, Foraminifera of, W. L. F. Nuttall, 112.

VALIDITY in Geological Theory, E. Greenly, 176.
Veatch, J. O., Soil Survey Work in America, 45.
Versey, H. C., Petrography of the Carstone and Associated Beds, 287.
Volcanic Eruptions in the Central Alpine Zones, C. G. S. Sandberg, 469.
Volcanic Vents at Seacliff and Whitberry Point, N. Berwick, T. C. Day, 45.
von Bubnoff, S., Geology of Europe, Vol. I, 558.
von Zittel, Karl A., Text-book of Palaeontology, Vol. III, Mammalia, 89.
Vredefort and Arran Domes, E. B. Bailey, 481.
Vulcanism and Metallogeny, A. Holmes, 335.
Vulcano-Glacial Palagonite Formation of Iceland, M. A. Peacock, 385.

WALKER, F., The Problem of the Quartz-dolerites, 187.
— — Teschenite Sill of Charlestown, Fife, 343.
Watersheds, Tramps Across, A. S. Alexander, 180.
Wayland, E. J., Petroleum in Uganda, 431.
Wegener, A., Origin of Continents and Oceans, 181.
Wells, A. K., Petrology of the Igneous Rocks, 282.
Wigtownshire, Mica-Lamprophyres of, H. H. Read, 422.
Williams, Daisy M., Upper and Lower Old Red Sandstone, 219.
— K. E., Curious Marks on a Rock Surface, 341.
Williston, S. W., the late, Osteology of the Reptiles, 227.
Wilson, R. C., Brown Coal in Nigeria, 42.
Withers, T. H., Decapod Crustaceans (*Callianassa*) from Barbados, 104.
Woolacott, D., Superficial Deposits near Sunderland, 1.
Wooldridge, S. W., Outliers of Lenham Beds, Sanderstead, Surrey, 94.
— — Structural Evolution of the London Basin, 44.
Woods, H., Invertebrate Palaeontology, 180.
Wright, J., Anal Plates of *Eupachycrinus calyx* and *Zeacrinus konincki*, 145.

YAKOWLEV, N. N., Explanations of the Bilateral Symmetry of Rugose Corals, 264.
Yeovilian Ammonites, Yorkshire Moors, W. E. F. Macmillan, 287.
Yorkshire Geological Society, 46, 287.
Yorkshire, Post-Glacial Deposits, A. Raistrick, 255.
Young, G. W., Shoshone Valley, Yellowstone Park, U.S.A., 286.
Young, W. H., Drainage of the Foothills from Masham to Wetherby, 287.

ZONAL Distribution of Eocene Foraminifera of W. India, W. L. F. Nuttall, 495.

Printed by Stephen Austin and Sons, Ltd., Hertford.